FIG. 1. Interior View of a California Fruit-Canning Plant

THE CANNING *of* FRUITS *and* VEGETABLES

BASED ON THE METHODS IN USE IN CALIFORNIA, WITH NOTES ON THE CONTROL OF THE MICROORGANISMS EFFECTING SPOILAGE

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DEDICATED

TO

CARLOS A. GALARCE

AND

ALFREDO M. TELLO

INTRODUCTION

Human beings may be traced in almost any part of the globe through the tin cans which they leave behind them.

Certainly, anywhere in North America where people have spent a day, there you may find this sign of their occupancy.

To-day the retailer receives from the wholesaler the larger portion of his food supplies in a package, which is transmitted unbroken to the consumer. A grocery-store consists largely of a collection of original packages.

Of all these sanitary devices, the tin can is probably the most significant and the most universal. Fruits, vegetables, meats and milk have all been subjected to the virtue of this humble container. Nicholas Appert, in France, first preserved food in glass jars by sealing them hermetically and heating. He published "The Art of Preserving Animal and Vegetable Substances" in 1811. In 1810 Peter Durand obtained a patent in England for preserving fruits, vegetables and fish by hermetically sealing them in *tin* and glass cans. In 1820 William Underwood and Charles Mitchell, emigrant employees from a canning factory in England, opened a factory in Boston where they canned plums, quinces, cranberries and currants. Glass was used exclusively until 1825, when Thomas Kensett secured a patent for use of *tin* cans and commenced to use them in his factory.

The preservation of foodstuffs lies in controlling the action of microorganisms. There are four methods of control in general use—desiccation, addition of toxic substances, refrigeration and exclusion. It is the method of exclusion, by placing in a sealed container and then heating, that is coming to be the most acceptable method for preserving the delicate flavor of

our highly prized foods. By this means, people in the remotest portions of the globe may indulge in fastidious gastronomic feats.

Nowhere, perhaps, has the preservation of fruits and the production of a standard and attractive package been brought to a higher perfection than in California. The author of this work, who is a graduate of the College of Agriculture of the University of California, has taken advantage of the opportunities offered, by the study of the underlying principles at the university and by personal practical experience in several of the factories of the State. He has brought together a mass of scientific and practical information which has not heretofore been available to the public. He has, himself, made contributions to the study of the preservation of fruits and vegetables. It is to be hoped that his labors may result in increasing the present high quality of our foods, as well as in preventing waste. He will thus be contributing to the realization of a uniform and satisfactory food supply for the human race.

THOMAS FORSYTH HUNT,
Dean of the College of Agriculture of the
University of California.

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PART ONE—FRUIT-CANNING

IMPORTANCE OF THE CANNING INDUSTRY

The canning of fruit and vegetables is at the present time one of the most important industries of California, and the growth of this industry is best illustrated by the following statistics:

TABLE No. 1

U. S. Exports of Canned Goods

Fiscal Year	Value
1905– 6	$2,348,064
1906– 7	1,348,064
1907– 8	1,549,826
1908– 9	2,899,374
1909–10	2,656,019
1910–11	2,686,445
1911–12	4,012,463
1912–13	5,599,373

TABLE No. 2

California Canned Fruit and Vegetable Pack

Year	Fruits (Cases)	Vegetables (Cases)
1900	2,775,896	803,617
1901	2,677,072	1,076,058
1902	2,252,790	1,151,268
1903	2,733,504	1,343,574
1904	2,839,733	961,783
1905	3,283,296	1,192,455
1906	3,109,225	1,747,595
1907	2,982,955	1,941,755
1908	4,734,663	1,501,885
1909	3,047,001	1,242,720
1910	4,008,549	2,250,645
1911	4,182,650	2,516,655
1912	4,833,900	2,789,495

The growth of the packing industry, according to the varieties of fruit in California, will be noted from the following tabulated

report, compiled by one of the leading orchardist journals of California, viz.: *The California Fruit Grower*, for the years 1910, 1911 and 1912.

TABLE No. 3

Canned Fruit and Vegetable Pack of California

Compiled Yearly from Individual Packers' Reports

	1910 (Cases)		
	No. 2½, 3 and Smaller (All Grades)	Gallons (All Grades) in Equivalent of 12-Can Cases	
Fruits			
Apples	6,280	70,550	
Apricots	544,530	198,630	
Blackberries	26,475	35,600	
Cherries, Royal Ann	123,240	13,050	
Cherries, black	18,110	1,510	
Cherries, white	33,410	5,875	
Grapes	39,285	6,360	
Loganberries	6,977	5,662	
Pears	568,125	551,230	
Peaches, free	553,000	195,825	
Peaches, cling	1,233,200	163,425	
Plums	65,550	14,810	
Raspberries	9,335	791	
Strawberries	13,225	848	
Other fruits	2,250	1,441	
Total fruits	3,242,992	1,265,607	
Grand total fruits (cases)			4,508,599
Vegetables			
Asparagus	614,050	3,225	
Beans	41,610	4,640	
Peas	140,855	26,920	
Tomatoes	1,159,875	190,435	
Other vegetables	49,075	19,960	
Total vegetables	2,005,465	245,180	
Grand total vegetables (cases)			2,250,645
Grand total pack (cases)			6,759,244

TABLE No. 3 (*Continued*)

Canned Fruit and Vegetable Pack of California

Compiled Yearly from Individual Packers' Reports

Fruits

	1911 (Cases)		
	No. 2½, 3 and Smaller (All Grades)	Gallons (All Grades) in Equivalent of 12-Can Cases	
Apples	8,750	56,550	
Apricots	708,500	149,825	
Blackberries	35,250	42,575	
Cherries, Royal Ann	99,700	11,740	
Cherries, black	26,860	2,005	
Cherries, white	49,730	8,770	
Grapes	62,115	8,800	
Loganberries	12,106	7,011	
Pears	579,960	38,960	
Peaches, free	582,200	156,200	
Peaches, cling	1,210,525	142,200	
Plums	143,350	22,490	
Raspberries	2,950	675	
Strawberries	6,505	1,210	
Other fruits	1,395	3,743	
Total fruits	3,529,896	652,754	
Grand total fruits (cases)			4,182,650

Vegetables

Asparagus	684,960	2,105	
Beans	53,110	12,710	
Peas	162,570	22,205	
Tomatoes	1,306,190	209,260	
Other vegetables	39,575	23,970	
Total vegetables	2,246,405	270,250	
Grand total vegetables (cases)			2,516,655
Grand total pack (cases)			6,699,305

TABLE No. 3 (*Continued*)

CALIFORNIA CANNED FRUIT AND VEGETABLE PACKS FOR 1912, 1913 AND 1914—(From Packers' Returns)

Published by permission from the annual Review Number of *California Fruit News*

Fruits

	1912 (CASES)		1913 (CASES)		1914 (CASES)	
	No. 2½, 3 and Smaller (All Grades)	Gallons (All Grades) Number of Dozens	No. 2½, 3 and Smaller (All Grades)	Gallons (All Grades) Number of Dozens	No. 2½, 3 and smaller (All Grades)	Gallons (All Grades) Number of Dozens
Apples	9,185	84,225	2,305	29,230	9,500	70,750
Apricots	949,475	192,880	714,970	133,910	772,775	125,230
Blackberries	24,080	59,790	27,370	48,040	55,375	46,630
Cherries	97,295	8,930	150,215	12,450	319,335	32,560
Grapes	43,210	6,475	35,215	6,450	40,960	6,225
Loganberries	10,900	5,000	12,465	3,270	16,965	4,415
Pears	749,425	56,315	488,370	41,490	832,350	41,850
Peaches, free	684,050	204,075	523,475	245,275	480,660	103,140
Peaches, cling	2,325,275	296,380	1,508,500	121,300	1,469,275	160,980
Plums	89,400	21,040	52,770	13,205	148,990	26,300
Raspberries	3,890	580	5,165	425	8,520	570
Strawberries	16,140	1,995	8,465	790	25,800	8,670
Other fruits	17,305	11,560	7,675	1,730	23,565	2,510
Total fruits	5,019,630	949,245	3,536,960	657,565	4,204,070	629,830

Grand total fruits (cases) 9,028,425

Vegetables

Asparagus	762,035	6,775	716,650	6,350	714,900	4,300
Beans, string	67,860	9,205	83,255	6,935	76,690	7,665
Peas	149,320	12,775	86,970	6,900	251,275	18,150
Tomatoes	1,680,960	212,700	989,550	157,010	1,396,900	224,200
Other vegetables	103,855	22,780	103,365	35,345	66,390	29,025
Total veget.	2,764,020	264,235	1,979,790	212,540	2,506,155	283,340

Grand total vegetables (cases) 4,981,825
Grand total pack (cases) 14,010,250

We will endeavor to describe the system in general use by all of the canners of California, in the purchase of the green fruit, the receiving, the packing, as well as the labeling and shipping.

PURCHASE OF GREEN FRUIT

Practically all of the fruits are contracted for in advance by the canners in the earlier ripening periods in the orchard. The canners send out to the growers green fruit buyers, who analyze the crop conditions and purchase the crop, either on the trees or delivered at the nearest railroad station, and, in the case of the cannery being near the orchard, delivered to the cannery. The form of contract used between the canner and grower is herewith presented:

No. 1548.

DUPLICATE

Entered.............................
.... Cal...................19...
....
of.....................................has sold, and..................
.....................has bought.........................crop of fresh fruits and vegetables grown at..
of the following varieties and estimated quantities delivered at............
.... or...................... or..........
during the season of.................. to..............................
inclusive, all to be of good merchantable quality, free from worms, scale, or other imperfections, suitable for canning purposes, and in good order and condition at time of delivery. Any soft, small or inferior fruit to be weighed back and deducted. Seller agrees to pick and handle fruit without bruising. The fruit, after picking, to be placed immediately in the shade or under cover, with proper ventilation. All fruit to be hauled to cannery, or point of shipment, in wagons equipped with springs, and all loads to be covered with canvas or some suitable covering, as protection against sun, dust and dirt. It is optional with the buyer to take any fruit not up to specifications of this contract at market price, and seller agrees not to sell same to others without knowledge and consent of the buyer. In case buyer cannot use fruit not up to specifications of this contract, same is to be held subject to order of seller or turned over to..
at..without notice.

Payment in settlement of this contract to be made, one-third in 30 days; one-third in 60 days; one-third in 90 days after completion of deliveries.

If seller shall be unable to deliver fruit owing to destruction of crop by flood, frost or any unavoidable casualty, or if buyer shall be unable to operate owing to strikes, fire, or any unavoidable casualty, this contract shall be null and void upon written notice by either part to the other of inability to perform.

It is understood that seller shall till, cultivate, fertilize and irrigate the soil, prune, spray and thin trees where said fruits are grown, in the manner customary and necessary to the proper care and growing of same during the full term of this contract.

If a load of fruit is adjudged by the buyer not to be up to specifications of contract, it is optional with the buyer whether he grades said load or not.

It is mutually agreed between the parties hereto that the covenants herein contained shall go with the land herein above described and shall bind both the parties hereto, their heirs, administrators, executors, successors, and assigns.

Seller agrees to pay one cent per box as rental for all boxes furnished by buyer, and further to pay buyer twenty-five cents each for all boxes not returned.

Varieties	Price per Ton	Size-Ring Measure Not Less Than
Lemon cling peaches	$20.00	2¼ in. in diameter and up
Tuskena	25.00	
Phillips	22.50	
Lovell, freestone	17.50	
Muir, freestone	17.00	
Pears, Bartlett	30.00	2½ in. in diameter and up
Cherries, black	75.00	
Cherries, white	60.00	
Cherries, Royal Ann	100.00	
Berries, blackberries	55.00	
Berries, raspberries	80.00	
Berries, strawberries	100.00	
Plums	15.00	

....Seller

Per..................................Buyer

HEAVIEST CANNING SEASON IN CALIFORNIA

In closing the paragraph referring to the contracting for fruit, it might be well to state at this time that to-day many of the California canners are making five- to ten-year contracts with the growers. The periods of ripening of the various fruits are shown in the following table, which gives an idea of the heaviest canning season in California:

Asparagus	March 12 to July 7
Peas	April 20 to July 31
Strawberries	May 8 to October 23
Gooseberries	May 15 to June 19
White cherries	May 15 to July 2
Black cherries	May 17 to July 4
Royal Ann cherries	May 21 to July 18
Blackberries	May 31 to October 19
String beans	June 2 to November 30
Apricots	June 5 to August 25
Currants	June 6 to June 28
Raspberries	June 6 to August 7
Egg plums	June 25 to September 23
Golden drop plums	June 30 to September 21
Damson plums	July 1 to October 23
Green gage plums	July 2 to September 18
Yellow free peaches	July 2 to October 24

Yellow cling peaches	July 10 to November 12
Nectarines	July 15 to September 6
Pears	July 16 to November 8
Apples	July 18 to November 30
White free peaches	July 22 to October 15
White cling peaches	July 31 to October 20
Grapes	August 11 to November 14
Quinces	September 14 to November 14
Tomatoes	August 30 to November 25

GREEN FRUIT OR RECEIVING ROOM

In considering the building of a cannery, the green fruit or receiving room should be located at a point nearest the railroad, or to the best advantage for receiving the fruit from the orchard by team. This room should also be the office where the general business of the cannery is transacted. It should be of such a size as to facilitate the storage, sorting or grading and weighing, and especially should be in charge of a man of large experience in judging the quality and varieties of fruit; one who is well acquainted with the grower and especially with the terms of the contract.

The receiving room should be of ample size to permit liberal storage of unripened fruit, and this room should contain the following machines:

Platform Scales
Cherry Graders
Peach and Apricot Graders
Fruit Trucks

SELECTION OF THE RAW MATERIAL

First—According to Size of Fruit:

(a) Large
(b) Medium
(c) Small

Second—According to Ripeness of Fruit:

(a) Green
(b) Medium
(c) Over-Ripened

Third—According to Appearance:

(a) Sound
(b) Blemished

The first grading is done by machinery, on what is termed a Fruit Roller Grader, which is shown in Fig. 2.

The second grading is done by hand in order to send to the preparation room fruit whose condition of ripeness will not permit of its being kept in storage for two or three days; also to

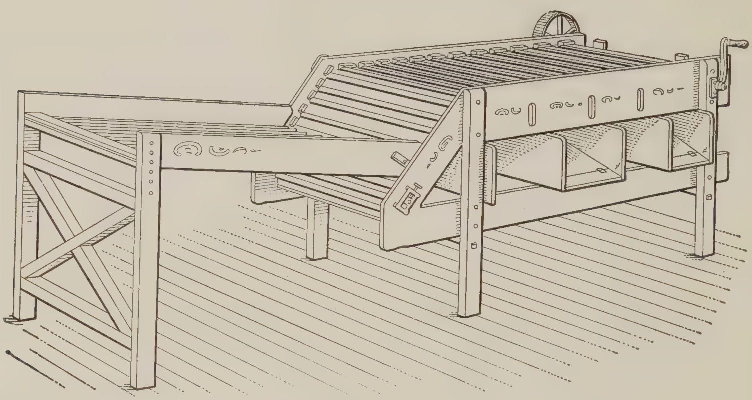


Fig. 2. Fruit Roller Grader

Specifications

Machine	Capacity per Day	T. & L. Pulleys	Speed R.P.M.	Floor Space
No. 1, 24″, 4-grade......	12 Tons	22″ x 2″	30	3′ 3″ x 8′ 5′
No. 2, 24″, 5-grade......	15 "	22″ x 2″	30	3′ 3″ x 9′ 6″
No. 3, 30″, 4-grade......	16 "	22″ x 2″	30	3′ 9″ x 8′ 5″
No. 4, 30″, 5-grade......	20 "	22″ x 2″	30	3′ 9″ x 9′ 6″

regulate the work of the cutters. If the fruit is all of large size, the operators will use a great deal of the fruit in a very short period, thereby exceeding the capacity of the other departments of the cannery The operators must not cut such a large quantity of fruit as cannot be successfully peeled, put into the cans and processed, for the reason that if the fruit remains cut for a comparatively long period its quality and appearance will be badly damaged, resulting in a very poor pack.

After the fruit is graded in the receiving room it is sent to the cutters, who sit at a long table with a flat surface and so

arranged that they can have a box placed at their right to take the fruit from and peel it, placing it in trays or on belts to be removed from the peeling table to the canning table.

In cutting the fruit the majority of canners use canning knives, as shown in Figs. 3 and 4.

The third sorting is done in order to separate the sound fruit

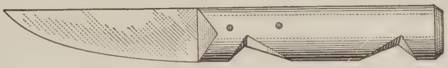


Fig. 3. Eureka Knife

from the blemished. In this way any fermentation, which might otherwise occur, will be prevented.

As has been stated before and shown by the specimen of contract, fruit is bought by the ton and is received in the cannery in wooden boxes, commonly called in California "lug" boxes, of a capacity varying from 36 to 40 pounds net.

Few of the canneries of California are located at the orchard, but are situated in a locality that furnishes a considerable quantity of cheap help, for it has been determined best to locate

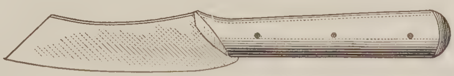


Fig. 4. Pacific Knife

the cannery where help is in abundance, and bring the fruit to it. The result is that fruit has to travel in many cases anywhere from 50 to 200 miles before it reaches the cannery. Fruit thus shipped is placed in open ventilated cars covered with a tent. The boxes used for the transportation of this fruit are returned by the railroad to the cannery free of expense.

The receiving department or green fruit room should be constructed with a good system of ventilation. The floor should be waterproof, as in this condition the cleaning of it becomes

easy. Cleaning should be done every day in this department, so as to keep it thoroughly sanitary, getting rid of all decayed fruit.

PREPARATION ROOM

We described above the method by which clingstone and free peaches are cut, in order to divide them in half and remove the pits. We, however, neglected to state that after peaches and

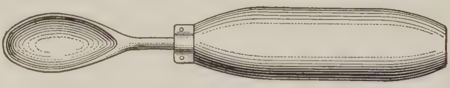


FIG. 5. Carmichael Pitting Spoon

apricots are cut in halves, it is necessary in the case of the clingstone peaches to remove the pits or half pits, and to accomplish this in California they have a special peach pitting knife, as shown by Fig. 5. It is known as "Carmichael pitting spoon."

HAND-PEELING SYSTEM

In the preparation room and after the peaches or apricots are cut in half and the pits removed, in California they have two systems of peeling the fruit. One is called "the hand-peeling system" and the other is called "machine peeling" or "lye peeling system." In the former method a special knife, called the "pomona peach peeling knife" is used. This

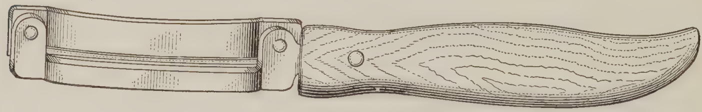


FIG. 6. Pomona Peach Peeling Knife

knife is so constructed as to remove the skin of the fruit with very little of the meat. The form of this knife is shown in Fig. 6.

It might be well while referring to the cutters to state that

their supervision must be very carefully controlled, for when the operators are peeling the peaches by hand, a great deal of attention must be given to seeing that they place the peeled peaches in the various assorted trays according to their size and quality. This is called the classification of fruit according to its ripeness and appearance. This operation by the hand peelers is probably one of the most important features of the work done in the preparation room, for the fruit is sorted by the hand peelers as follows:

(a) Green
(b) Medium
(c) Soft
(d) Pie
(e) Blemished

Green Fruit—Fruit which is not perfectly ripe, but is sound and of good size.

Medium Fruit—Fruit of an ordinary size, sound and sometimes larger than green fruit and in a good condition of ripeness.

Soft Fruit—Fruit which is also of good size and sound, but shows a greater degree of ripeness than the medium.

Pie Fruit—Fruit which is over-ripened and which should be used for pie-making or sold as cheaper grade.

Blemished Fruit—In this sort of fruit we find all degrees of ripeness. It is not sound, and is generally placed in what is called gallon pie fruit and termed the "pie grade."

We described above the cutting tables, and in the preparation room the tables are placed in such a way as to allow ample room for passage to the workers. The work done by the cutters ought to be in charge of a skilled foreman. If the sorting of fruits is correctly done, the work of the canners will be greatly simplified, for in the hand peeling a great deal of the grading is accomplished by the peelers. After they have peeled the fruit, they place it in the different trays, which, in turn, go to the canning tables. Here the operators place it in the cans and make the proper grades thereon.

LYE PEELING SYSTEM

The second system in the preparation room is called the "lye peeling system." The lye peeling machine (Fig. 7) consists of a conveyor or a revolving system that carries the fruit through a caustic soda bath very rapidly, which removes the outer skin or peel of the fruit and does not damage its quality. This machine is used in practically every cannery in California, there being only one cannery at the present time devoted exclusively to hand peeling.

The strength of the solution which is contained in the peeler varies with the temperature of the water and the variety and ripeness of the fruit. A 10% solution of Caustic Soda (Na OH) is used for peeling peaches. Using water at boiling-point would not do any harm to the fruit. The average caustic soda used by the cannery is called "78% hydrate."

The same solution can be used for the peeling of apricots, but in the peeling of apricots it requires a weaker solution. The temperature of the water and the strength of the solution must be tested several times during the day's work, to increase or decrease its cutting power.

In the case of clingstone peaches or freestone peaches, much depends upon the ripeness or the greenness of the fruit. Contact with the caustic solution should be from 30 to 45 seconds.

BLANCHING

The fruit after being peeled is sent through what is termed the "blanching machine" (Fig. 8). This is a system of copper carriers that thoroughly blanches the fruit after it has been peeled and given the preliminary washing in the revolving scalder or peeler.

GRADING

After the foregoing treatment, the fruit is automatically carried to a peeled peach grader, as shown by Fig. 9. This machine is constructed so as to remove the large peaches first, for one

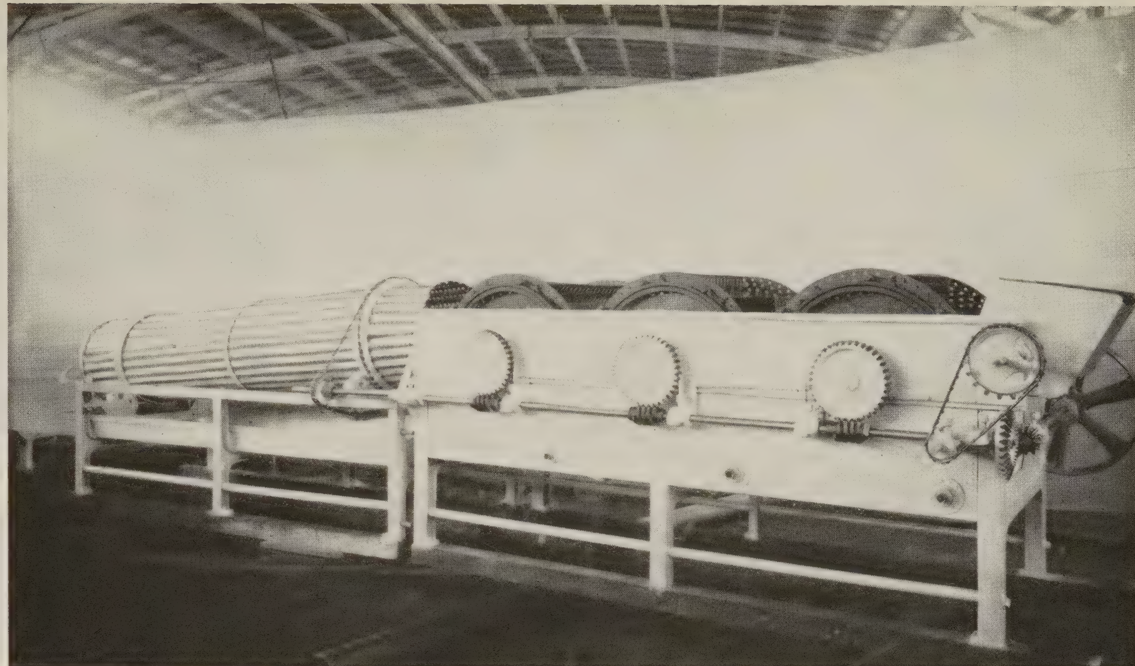


FIG. 7. Lye Peach and Apricot Peeler

SPECIFICATIONS

Style of Machine	Capacity per Day	T. & L. Pulleys	Speed R.P.M.	Floor Space	Style of Machine	Capacity per Day	T. & L. Pulleys	Speed R.P.M.	Floor Space
No. 1, 2 drum. .24″	30 Tons	17″ x 3″	45	2′ 6″ x 17′	No. 2, 2 drum. .36″	45 Tons	17″ x 3″	45	3′ 6″ x 17′
No. 3, 3 drum. .36″	60 "	17″ x 3″	67½	3′ 6″ x 20′	No. 4, 4 drum. .36″	75 "	17″ x 3″	90	3′ 6″ x 23′

must understand the largest peaches produce the highest grades. The large peaches are taken out first, the second grade next, and so on down until from five to seven grades are made. These machines are so constructed that just as soon as one grade is taken off, the peaches pass to a carrier belt on which they are conveyed to the canning tables, as shown in Figs. 10 and 11.

The carrier runs in a wooden trough or gutter placed at the top of the canning table. Here the women have to pick out all of the fruit bruised during the peeling process. At each basin on the canning table is what is termed a switch, and the operator, when she wishes to fill her basin full of peaches, simply turns the switch over the face of the belt and all the peeled peaches are guided into the basin. After the basin is filled she then turns off the switch and the peaches continue down the belt, each packer taking what is required. The type of canning table that is used largely by California canners is shown by Fig. 11. To give one a description of this type of table is rather difficult, as it would be necessary to know the number of peelers or basins needed and would require a description of the cannery. However, there are standard sizes used by the canners here, and these tables are built in units of six, three peelers to each side of the table.

All that has been mentioned heretofore deals with the preparation of apricots and peaches, but in the case of pears, plums, cherries, etc., the fruit is submitted to a different process of preparation.

In the case of pears, the fruit is all peeled by hand, which method we referred to in a previous paragraph.

For the removing of cores of the pears the canners use what is called the "Acosta pear corer," as shown in Fig. 12.

In the case of cherries, they have in California what is called a cherry grader, a cherry stemmer and a cherry pitter.

As stated before, pears without any exception are peeled and sorted by hand. The variety of pear mostly used for canning purposes is what is called the Bartlett. This variety of pear can be classified as follows: (a) long, (b) short. The first kind

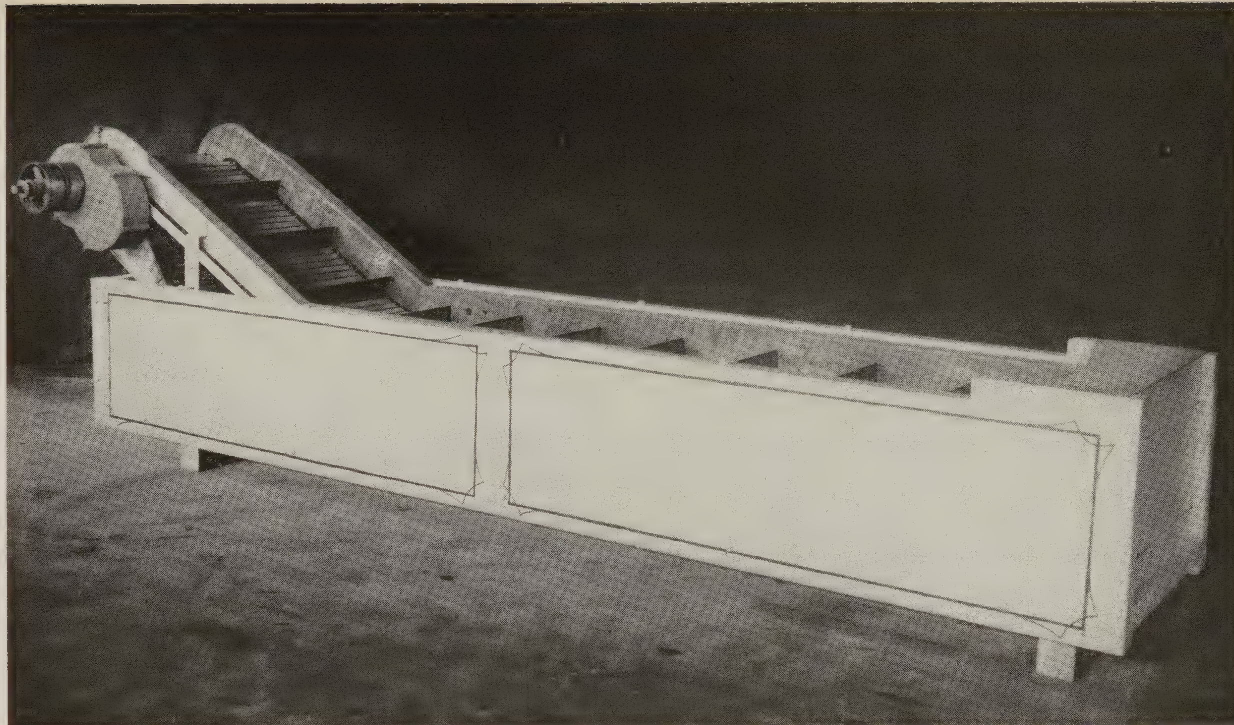


Fig. 8. Blanching Box

Specifications

Daily Capacity	T. & L. Pulleys	Speed R.P.M.	Floor Space
75 Tons................	8″ x 3″	88	3′ x 14′

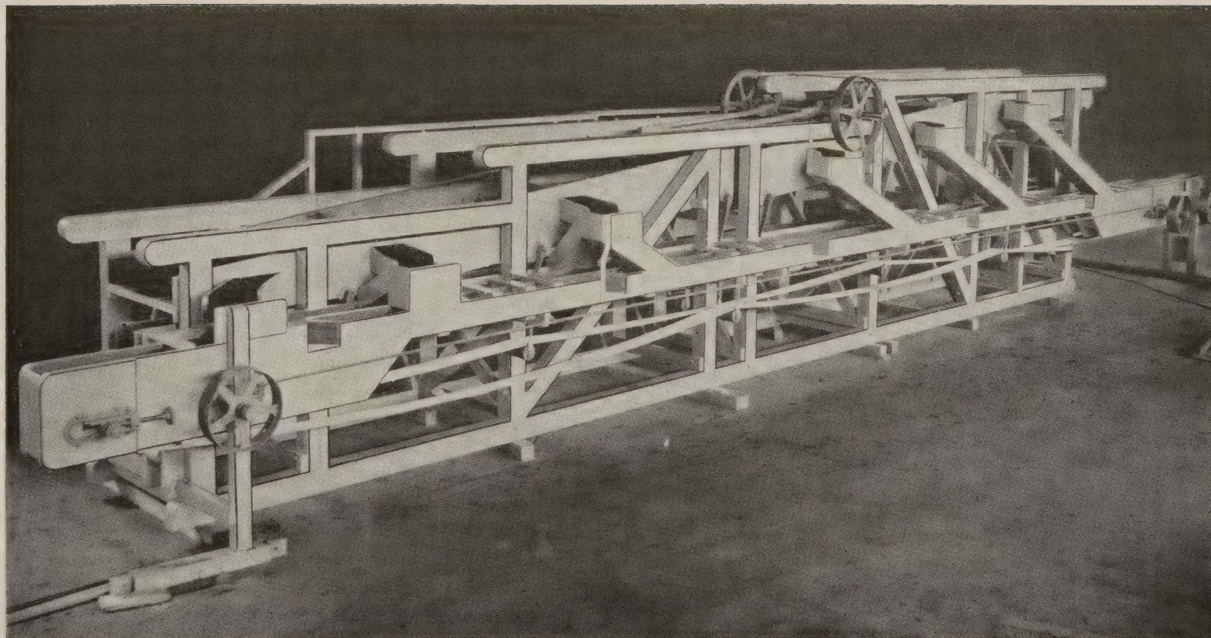


FIG. 9. Peeled Peach and Apricot Grader

SPECIFICATIONS

Daily Capacity	T. & L. Pulleys	Speed R.P.M.	Floor Space
75 Tons................	12″ x 4″	320	3′ 6″ x 40″

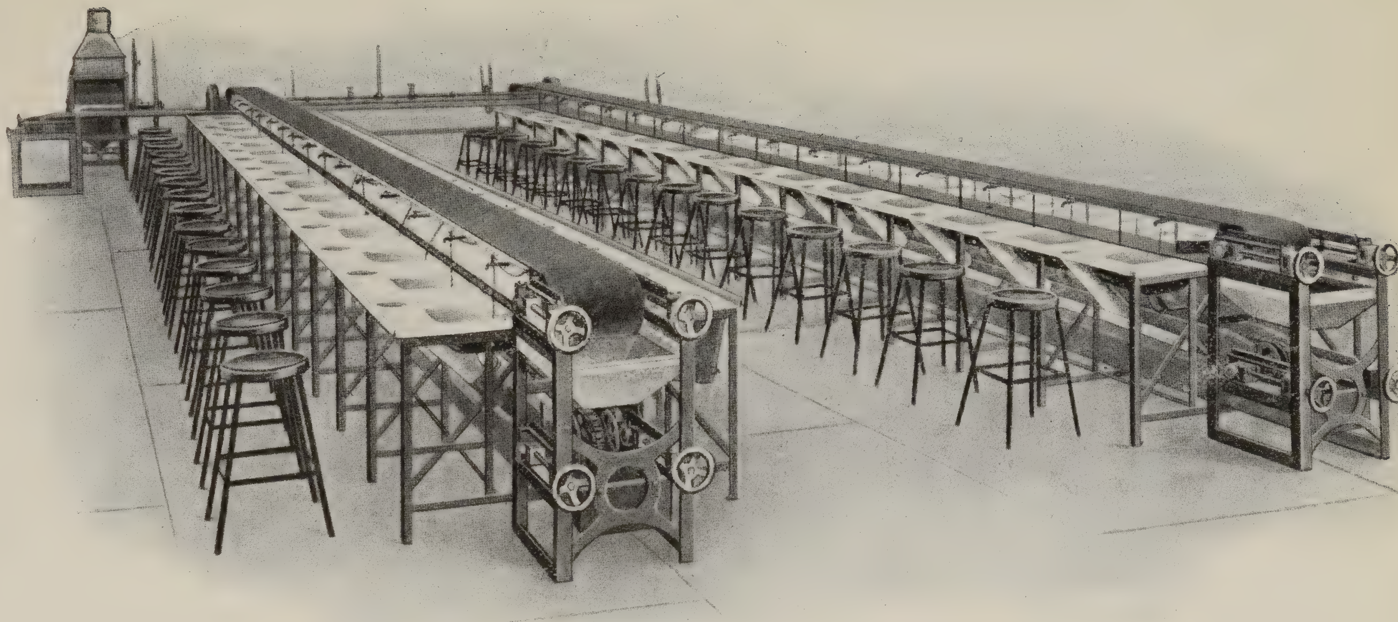


FIG. 10. Sanitary Peeling Table

of pear is canned in almost all sizes of cans; the second one only in small cans; the latter size is called 2½ and 3 "extra," and the former 2½ "Extra Standards" and "Standards."

In the grading of pears, what applied to peaches peeled by hand particularly applies to the hand peeling of pears. The work has to be done by skilled workwomen, and careful inspection must be made by the forewoman in regard to correct sorting and grading, according to size. The cutters have to classify the pears according to appearance and degree of ripeness. It is well to state at this time that the pear is a fruit that has to

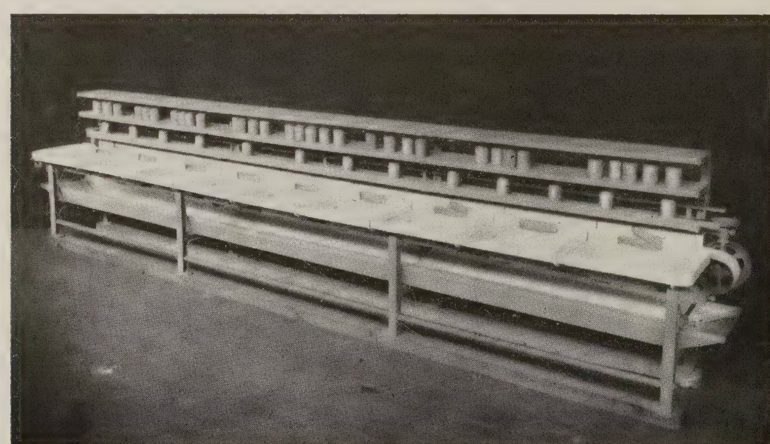


FIG. 11. Sanitary Canning Table

SPECIFICATIONS

Operators Accommodated	T. & L. Pulleys	Speed R.P.M.	Floor Space
9	12″ x 3″	150	3′ x 20′

be submitted to the operation of canning as quickly as possible, and must be very carefully handled, for the reason that on exposing it to the air it turns a brownish color very quickly due to the action of an oxidizing enzyme.

The canner in the packing of pears, when he finds it is not possible to can them soon after they are cut, places them in water in order to avoid the oxidization and browning that will otherwise occur.

Cherries are divided into five grades, and the machines used in the handling of cherries are as follows:

Cherry Grader
Cherry Sorting Tables
Cherry Pitters

The cherry grader (Fig. 13) is a vibrating screen consisting of five screens of various diameters, so that as the cherries roll

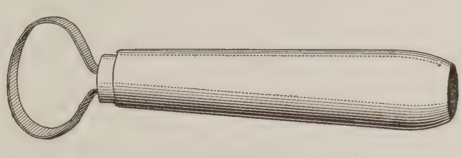


FIG. 12. Acosta Pear Corer

over the face of the screen they drop through the screen into hoppers which make the various grades.

Before the cherries go to the grading machine they are passed over what is called the stemming machine. This machine is so constructed that it automatically pulls off the stems from the cherries, so that when the fruit passes to the grader few stems remain.

The cherry sorting table is between the stemmer and the grader, and is used for picking off the stems of such cherries as have not had the stems removed by the stemmer.

Grapes have to be stemmed and sorted according to size, state of maturity and appearance. In the case of fancy packs, the seeds are removed.

In the grading of grapes and plums the cherry grader is used, though various size screens are then substituted for the cherry screens.

Berries are stemmed and sorted by hand.

CANS

The next important factor to be considered is the matter of cans. In California, and generally throughout the United

States, the majority of canners purchase their cans from a can company. However, there are quite a number of canners who are now considering the manufacture of their cans for reasons of economy.

Great improvement has been made in the manufacture and use of cans. The first cans were made with soldered seams throughout. The can in present use has very little soldering. A good history of the development of the fruit can will be found in Bulletin No. 151, U. S. D. A., by A. W. Bitting.

The tin can is made in a great variety of sizes and shapes, but there are certain forms known as standard.

Sizes of Standard Cans

Size	Diameter in Inches	Height in Inches	Capacity in Ounces Average
No. 1	$2\frac{9}{16}$	4	11.6
No. 1, tall	$2\frac{15}{16}$	$4\frac{1}{4}$	12.3
No. 2	$3\frac{5}{16}$	$4\frac{9}{16}$	21.3
No. $2\frac{1}{2}$	$3\frac{15}{16}$	$4\frac{3}{4}$	31.2
No. 3	$4\frac{3}{16}$	$4\frac{7}{8}$	35.
No. 3, tall	$4\frac{3}{16}$	$5\frac{1}{2}$	39.
No. 8	$5\frac{5}{16}$	$6\frac{7}{8}$	104.
No. 10	$6\frac{1}{16}$	7	107.

CANNING DEPARTMENT

In this department the canning tables are located. The material of which they are built is of great importance. There are a good many canneries in California still using canning tables of the earlier style, but if one will refer to Figs. 10 and 11 and the canning tables as described, he will see a style of table that is absolutely sanitary and meets the most exacting requirements of the canner.

One of the most important parts of a canning table is that in which the fruits are washed before they are canned. It is called the "fruit trough." In the old style of canning table it was made of zinc and coated with white paint. These fruit troughs have holes in their bottoms in order to secure a good drainage of the water used in washing the fruit. The new style of fruit

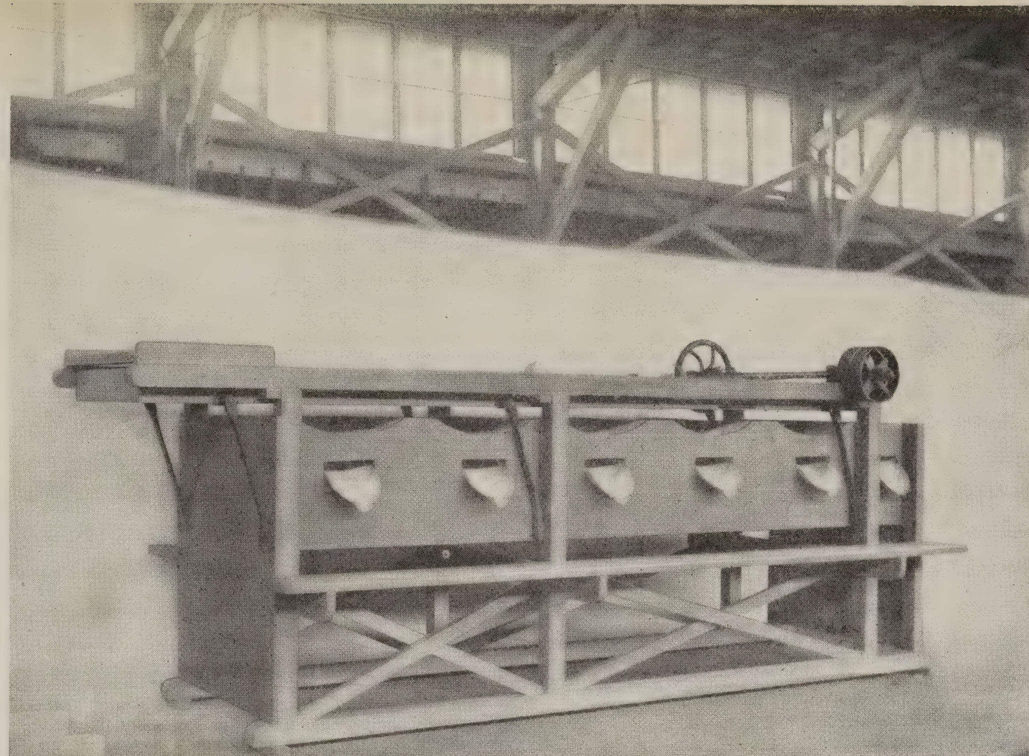


Fig. 13. Cherry and Olive Grader

Specifications

Machine	Capacity per Day	T. & L. Pulleys	Speed R.P.M.	Floor Space
No. 1, 18″, 4-grade......	10 Tons	8″ x 3″	360	2′ x 10′
No. 2, 18″, 5-grade......	10 "	8″ x 3″	360	2′ x 12′ 6″
No. 3, 24″, 4-grade......	15 "	12″ x 3″	360	2′ 6″ x 10′
No. 4, 24″, 5-grade......	15 "	12″ x 3″	360	2′ 6″ x 12′ 6″

trough is made of iron lined with porcelain. At the center of the bottom there is an outlet to allow the water to run off. Its angles are not sharp and the cleaning of it is very easy. It may be said without any reservation that this style of canning table should be adopted by all progressive canning plants. In using this system, many of the sanitary requirements which should be met in the canning industry are for the most part attained. Each division of the canning table has a hose to supply plenty of water for washing the fruit. This operation should by no means be neglected. The tables are located at right angles to the grader. As has been stated before, the latter has frames containing holes of five different diameters, to let the fruit fall down to a belt which carries it to the canning tables. This belt is placed in a wooden gutter. It has a cross-piece to regulate the entrance of the fruit to the fruit trough. There are some canneries which do not use graders at all. The fruit, after having been peeled by hand or by means of the lye peeler, reaches the canning tables by the aid of a combination of carriers. Each division of the canning tables has a scale to weigh the cans after they are filled with fruit. When using weights on the scales, it is necessary to regulate them every day, so that it has been found more convenient to use, instead of weights, cans containing the required weight. The way in which the pieces of fruit are put in the cans must be such as to give a good appearance to the latter. They are filled according to standard weights and not according to volume.

A practical example will give a better understanding of the weight and number of pieces contained in the cans. See Table 4.

Observing these figures, we find that the grades extra standard rough, standard rough, and second rough contain 10-12, 12-14, 14-18 pieces respectively. But we must note the fact that the fruit belongs to these grades because of its size, not on account of its appearance. For this reason they are called rough grades.

The same standard grades are used for peaches and apricots, but in this case we have to add sliced grades.

The type of fruit slicer used by California canners is shown by Fig. 14.

TABLE No. 4

PEARS

Grade of Fruit	Weight in Ounces	Number of Pieces	Size of Cans
Special extra	23½–24	8 to 10	2½
Extra	23½–24	10 to 12	2¼
Extra standard	23½–24	12 to 14	2½
Standard	23½–24	14 to 18	2½
Second	23½–24	18 to 22	2½
Pie	24 –25	....	2½
Water	24 –25	....	2½
Extra standard rough	23½–24	10 to 12	2½
Standard rough	23½–24	12 to 14	2½
Second rough	23½–24	14 to 18	2½
Extra	28 –30	7 to 11	3
Extra	14 –16	9 to 14	2
Extra standard	13 –14	9 to 12	1
Extra	68 –70	23 to 25	8
Extra standard	68 –70	40 to 45	8
Pie	80 –82	....	8

SLICED FRUIT

In peaches and apricots the following grades of sliced fruit are used:

TABLE No. 5

Grade of Fruit	Weight, Oz.	Size of Cans
Special extras	25–26	2½
Extras	25–26	2½
Extra standard	25–26	2½
Seconds	25–26	2½
Water	26–27	2½
Special extras	30–32	3
Special extras	14–15	1
Extras	14–15	1

These samples give us a general idea of the work done by the canners.

The same classification is applied to other fruits, but with slight variations depending on the variety of the fruit. This gives at the same time an idea of the care that the canners

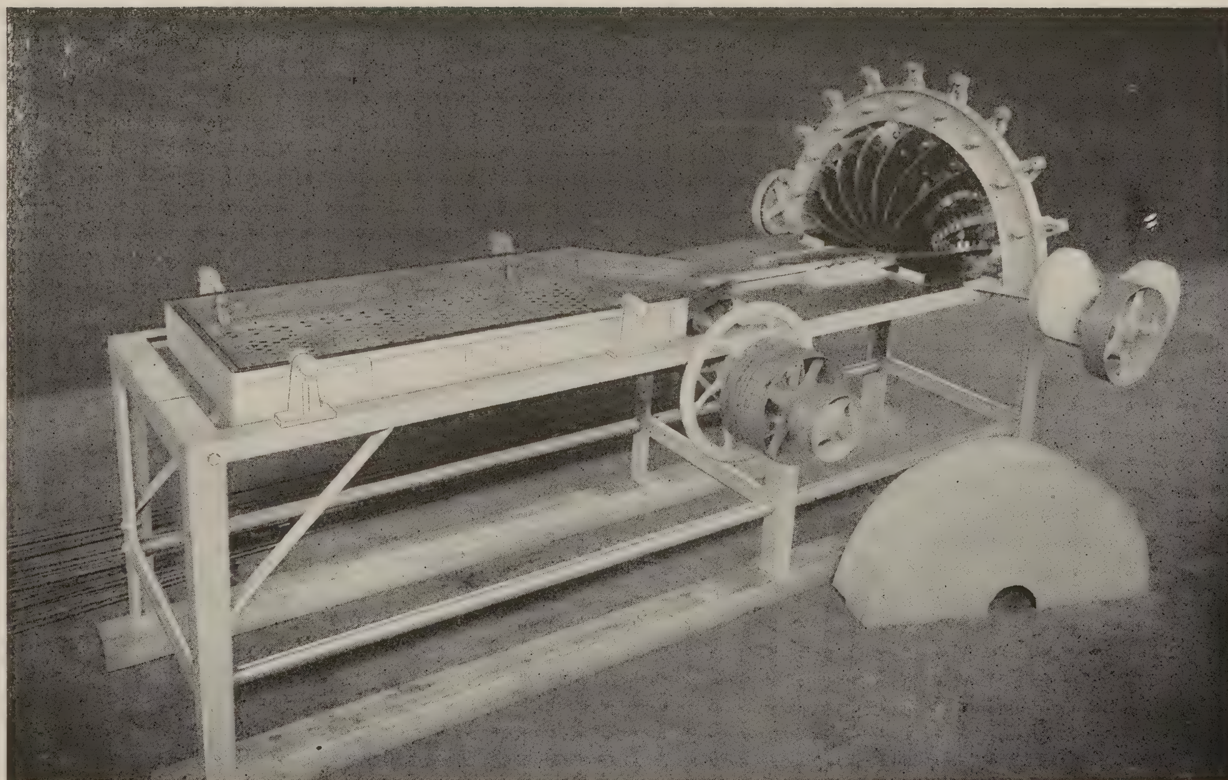


FIG. 14. Peach and Apricot Slicer

SPECIFICATIONS

Style Machine	Capacity per Day	T. & L. Pulleys	Speed R.P.M.	Floor Space
9-Knife.	20 Tons	12″ x 3″	200	3′ x 9′
6-Knife.	20 "	12″ x 3″	200	3′ x 9′

have to display and of the control that must be exercised all the time.

The women working at the canning tables are paid by the tray—the rate of wages being shown in the following table:

TABLE No. 6

Grade of Fruit	Size of Cans	Cans per Tray	Price Paid, Cts.
Special extra	2½	12	3
Extra	2½	12	3
Extra standard	2½	12	2½
Standard	2½	12	2½
Second	2½	12	2
Water	2½	12	2
Pie	2½	12	2
Special extra	1	20	4
Special extra	2	15	4
Special extra	8	5	3

These figures can not be taken as standard, for the simple reason that they vary from one factory to another. On the other hand, we consider it objectionable to pay for this work by the piece because it means rapid work or long hours to make good wages. Consequently, there is at all times a tendency to slight the work. Sometimes sufficient care is not exercised in eliminating defective material.

Waste During Canning of Fruits

Fruit	Per Cent Lost, as Peels, Pits, etc.
Apricots	10
Cherries	8
Peaches	39
Pears	42

Waste during canning is due to removing pits, skins, and spoiled fruit. The loss is greatest with pears and least with cherries. The waste of the Santa Clara fruit is used in some cases by the alcohol factory at Agnews. Peach pits are used for fuel or in nurseries; apricot pits are sent to Germany, where the kernels are made into toilet creams, etc.

YIELD OF CANNED FRUIT PER TON, CALCULATED AS CASES

1 Case = 2 Dozen Cans

Fruit	
Pears	37½ Cases
Peaches	40 "
Apricots	55 "
Cherries	60 "
Plums	60 "
Tomatoes	25 to 33 "

STAMPING OF THE CANS

All cans used for canning purposes should be stamped with a simple combination of letters in order to facilitate: 1—Their identification; 2—The syrup to be used in filling them; 3—The length of time they have to be processed. Besides this, each can should bear the number of the canner. In this way all mistakes made during the canning process can be noticed, and therefore easily rectified. In case of repetition of the same fault the canners should be discharged.

There are different systems of stamping cans, but it may be said that each cannery has its own system; nevertheless, the best of all is that in which the cans are stamped as they are needed by the canners.

In some canneries tables on which the cans are stamped are located near the canning tables. In this case the cans should be placed in wooden trays with raised bottoms. It sometimes happens that the stamper does not understand the combination of letters used with certain grades of fruit, and in some cases the boy who carries the cans to the canners delivers the wrong cans. The canners, being paid by the tray, work at high speed and pay no attention to the combination of letters on the cans, and for this reason may fill a can with the wrong grade of fruit.

The cans should be very carefully washed before being stamped, otherwise particles of dirt will be found in them which will lend a very bad appearance to the finished product.

The cans should be carefully inspected before being delivered to the canner, in order that any defects in the seams may be discovered in time. By delegating an extra man to perform

this operation, much labor on the part of the other men is saved, which would have been wasted had the defective cans been allowed to go through.

The can factory makes certain allowance for leaks (varying with the size of the can), but the commercial value of the fruit is lessened when defective cans are used, as they must be reprocessed in order to locate the leaks. Besides this, particles of lead are liable to get into the can when the lead is soldered.

SYRUPING ROOM

As soon as the cans are filled with fruit, they are sent to this department. Here the cans are filled with syrup, whose specific gravity varies with the grade of the fruit.

The grade of the fruit is identified by the combination of letters stamped at the bottom.

GRADES OF SYRUP

The grades of syrups most commonly used are as follows:

TABLE No. 7

PEACHES

Syrup, Degrees	Grade of Fruit	Kind of Fruit	Variety
60%	Special Extras	Sliced	Crawford & Muir*
60%	" "	"	Phillips, Orange, Tuskena
50%	" "	Halves	Phillips, Nicholl, Tuskena, etc.
50%	" "	"	Crawford & Muir*
50%	Extras	Sliced	" "
50%	"	"	Phillips, Tuskena, Nicholl
40%	"	Halves	" " Crawford
40%	Extra Standards	Sliced	" " Orange, Muir*
30%	" "	Halves	" " Orange, Muir*
30%	Standards	Sliced	" " Orange
20%	"	Halves	" " Orange, Nicholl
20%	Seconds	Sliced	" " Orange, Nicholl
10%	"	Halves	" Muir, Crawford*
00%	Water		" " "
00%	Pie		" Tuskena "

* Free stone peaches.

TABLE No. 8

APRICOTS

Syrup, Degrees	Grade of Fruit	Kind of Fruit	Variety		
50%	Special Extras.......	Sliced......	Moorpark,	Blenheim,	Royal
50%	" "	Halves.....	"	"	"
40%	"	Sliced......	"	"	"
40%	"	Halves.....	"	"	"
30%	Extra Standards.....	Sliced......	"	"	"
30%	" "	Halves.....	"	"	"
20%	"	Sliced......	"	"	"
20%	"	Halves.....	"	"	"
10%	Seconds............	Sliced......	"	"	"
10%	"	Halves.....	"	"	"
00%	Water..........................		"	"	"
00%	Pie............................		"	"	"

TABLE No. 9

PEARS

40%	Special Extras...........................	Bartlett
30%	"	"
20%	Extra Standards.........................	"
15%	"	"
10%	Seconds.................................	"
00%	Water...................................	"
00%	Pie.....................................	"

TABLE No. 10

CHERRIES

40%	Special Extras..................	Royal	Ann.	B.	Tartarian, etc.
30%	"	"	"	"	"
20%	Extra Standards................	"	"	"	"
15%	"	"	"	"	"
10%	Seconds........................	"	"	"	"
00%	Water..........................	"	"	"	"
00%	Pie............................	"	"	"	"

TABLE No. 11

PLUMS

50%	Special Extras.......	Green-gage,	Washington,	Egg,	etc.
40%	Extras..............	"	"	"	"
30%	Extra Standards......	"	"	"	"
20%	Standards...........	"	"	"	"
10%	Seconds.............	"	"	"	"
00%	Water..............	"	"	"	"
00%	Pie.................	"	"	"	"

TABLE No. 12

GRAPES

40%	Special Extras..................	Muscat	of	Alexandria
30%	"	"	"	"
20%	Extra Standards................	"	"	"
15%	"	"	"	"
10%	Seconds........................	"	"	"
00%	Water..........................	"	"	"
00%	Pie............................	"	"	"

TABLE No. 13
STRAWBERRIES

60%	Special Extras
50%	Extras
40%	Extra Standards
30%	Standards
20%	Seconds
00%	Water
00%	Pie

TABLE No. 14
APPLES

40%	Extras
30%	Extra Standards
20%	Standards
10%	Seconds
00%	Water
00%	Pie

TABLE No. 15
LOGANBERRIES

50%	Special Extras
40%	Extras
30%	Extra Standards
20%	Standards
10%	Seconds
00%	Water
00%	Pie

TABLE No. 16
RASPBERRIES

50%	Special Extras
40%	Extras
30%	Extra Standards
20%	Standards
10%	Seconds
00%	Water
00%	Pie

TABLE No. 17
GOOSEBERRIES

50%	Special Extras
40%	Extras
30%	Extra Standards
20%	Standards
10%	Seconds
00%	Water
00%	Pie

TABLE No. 18
BLACKBERRIES

50%	Special Extras
40%	Extras
30%	Extra Standards
20%	Standards
10%	Seconds
00%	Water
00%	Pie

In California they have two styles of syruping machines. One machine is called a "Hand Syruping," commonly known as the "Caton Syruping Machine." This machine will syrup twelve cans at a time, and is shown in Fig. 15; the different sizes used for the different size cans are as follows:

1—Caton 12 can 3 lbs, 2½ lbs. and smaller.
1— " 20 " " " " "
1— " 5-gallon.

Where the canner is not syruping by hand we have in California what is termed the "Automatic Syruping Machine." The machine is so constructed that it automatically delivers fruit on to an exhaust box that exhausts the fruit. The types of syruping machines that are used by the California canners are shown in Figs. 16 and 17.

There are different ways of carrying the filled cans to the syruping machine. The best of all is that in which special trucks are used. These trucks have eight divisions or shelves on which three trays containing cans may be placed. This disposition of the trays makes it unnecessary for the edges of the

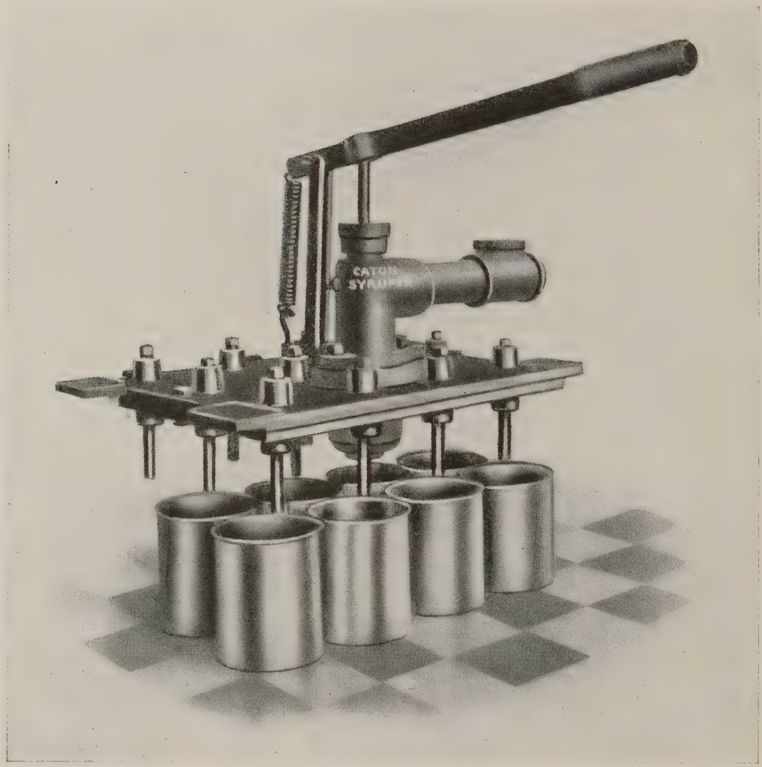


Fig. 15. Hand Syruping Machine

cans to receive the weight of the others. It also serves to decrease the number of leaks and to secure better work from the capping machine.

By using these trucks the cans are easily drained, because of the disposition of the sanitary syruping machines, which do

not allow more than one can to be handled at a time. This machine is built so as to fill automatically thirty-five cans and more per minute.

With the other type of syruping machine, *i. e.*, the "Caton Syruping Machine," the drainage of the cans cannot be accom-

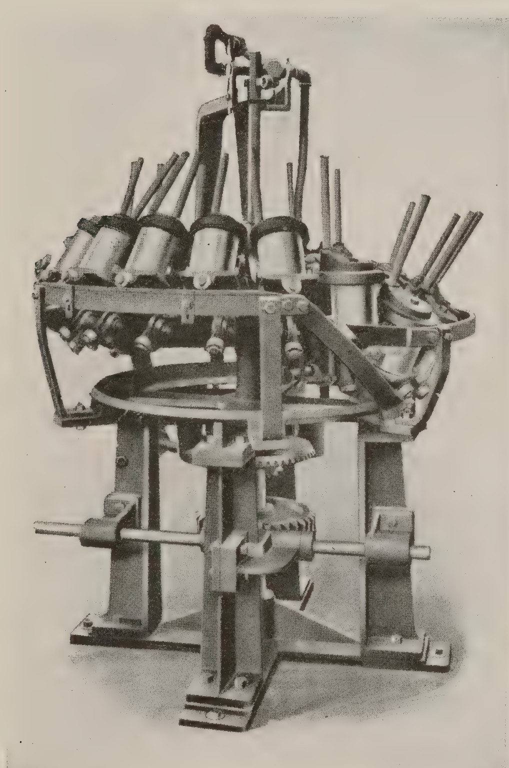


FIG. 16. Cerruti Sanitary Syruping Machine

SPECIFICATIONS

Capacity per Minute	T. & L. Pulleys	Speed R.P.M.
54 cans.	12″	108

To increase or decrease number of cans per minute, multiply by *two* the number of cans desired per minute and the result will be the number of revolutions per minute the drive pulley should run. Every two revolutions of the 12″ drive pulley fills one can.

plished except by using an extra man. The cans are held in trays, so the operation is greatly complicated. We have to take into account that the canners always leave water in the cans, and sometimes in such amount as to materially change the strength of the syrup.

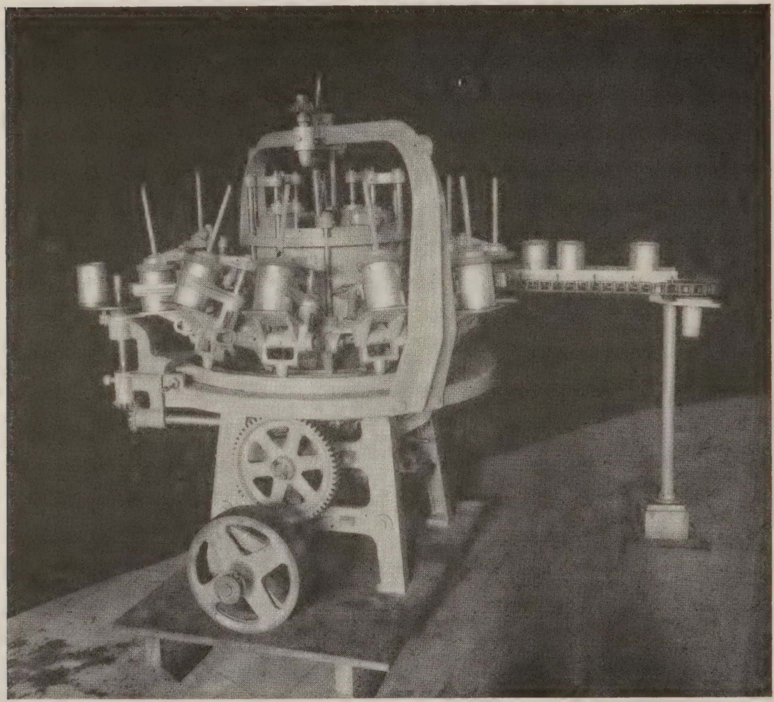


FIG. 17. Sanitary Syruping Machine

SPECIFICATIONS

Capacity per Minute	Pulley	Speed R.P.M.	Floor Space
60 cans...............	12″ x 3″	132.8	4′ 4″ x 4′ 9″

To determine R.P.M. multiply the number of cans per minute by 1.88.

In some canneries the cans containing fruit are piled up before going to the syruping machines. This practice results

in deforming the cans and crushing the pieces of fruit placed at the top of them. On the other hand, if the bottoms of the trays are dirty it will give a bad appearance to the product.

The amount of sugar used per case of cans may be seen in the following table:

TABLE No. 19

POUNDS OF SUGAR, PER CASE, INCLUDING MANUFACTURING WASTE

	Syrup, Degrees	48 14-Oz.	48 1	24	24–3	6–8 H_2O	6–10 Sanitary
Cherries							
S. Extras	40%	....	9.31	7.35	9.22	6.34	....
Extras	30%	....	6.20	5.73	6.70	4.35	....
E. Stands	20%	....	4.14	3.67	4.30	2.88	....
Standards	15%	....	3.21	2.65	3.24	2.12	....
Seconds	10%	....	1.95	1.74	2.08	1.34	....
Grapes							
S. Extras	40%	....	....	8.32	....	....	....
Extras	30%	....	7.01	6.72	....	4.92	....
E. Stands	20%	....	4.68	4.14	....	3.25	....
Standards	15%	....	3.52	2.96	....	....	....
Seconds	10%	....	2.24	1.90	....	....	....
Pears							
S. Extras	40%	....	....	6.65	8.10	5.79	....
Extras	30%	....	5.56	4.81	5.82	3.84	4.62
E. Stands	20%	....	3.57	3.15	3.92	2.63	....
Standards	15%	....	2.57	2.29	2.78	1.85	....
Seconds	10%	....	1.68	1.49	1.85	1.10	....
Apricots							
S. Extras	50%	....	10.04	9.91	11.91	8.60	....
Extras	40%	....	8.63	7.92	9.16	6.21	....
E. Stands	30%	....	6.89	5.53	6.89	4.44	....
Standards	20%	....	4.44	3.42	4.26	2.96	....
Seconds	10%	....	2.12	1.69	1.99	1.30	....
A. Sliced							
S. Extras	50%	....	....	5.62	8.95	6.14	....
Extras	40%	....	....	5.07	6.36	4.40	....
E. Stands	30%	....	....	3.92	4.67	3.65	....
Standards	20%	....	3.50	2.51	3.03	2.00	....
Seconds	10%	....	....	....	....	....	....
Egg Plums							
S. Extras	50%	....	....	11.21	13.03	9.67	....
Extras	40%	....	9.37	7.77	11.36	6.19	....
E. Stands	30%	....	7.07	6.05	7.29	5.08	....
Standards	20%	....	4.59	3.72	4.17	2.89	....
Seconds	10%	....	....	1.77	....	1.29	....
Green gage							
S. Extras	50%	....	13.86	10.42	12.67	8.62	....
Extras	40%	....	8.74	8.41	10.65	6.99	....
E. Stands	30%	....	7.53	5.58	7.81	5.32	....

POUNDS OF SUGAR, PER CASE, INCLUDING MANUFACTURING WASTE
(*Continued*)

	Syrup, Degrees	48 14-Oz.	48 1	24	24–3	6–8 H_2O	6–10 Sanitary
Green gage							
Standards....	20%	....	4.06	3.72	4.66	3.21	....
Seconds......	10%	....	....	1.81	....	1.40	....
Yellow Free Peaches							
S. Extras.....	50%	....	8.26	10.50	6.47	....	....
Extras.......	40%	....	8.02	6.21	8.42	4.94	....
E. Stands....	30%	....	5.41	4.13	5.79	4.14	5.61
Standards....	20%	....	3.60	2.65	3.39	3.22	....
Seconds......	10%	....	....	1.48	....	1.02	....
Yellow Free Sliced							
S. Extras.....	60%	....	....	11.00	7.87	....	6.46
Extras.......	50%	....	....	....	6.02	....	....
E. Stands....	40%	....	....	....	4.35	....	....
Standards....	30%	....	....	....	2.59	....	....
Seconds......	20%	....	....	....	....	....	....
Yellow Cling Peaches							
S. Extras.....	50%	....	....	8.15	10.27	6.46	....
Extras.......	40%	....	7.90	6.02	7.29	5.08	....
E. Stands....	30%	....	4.82	4.51	5.26	3.26	....
Standards....	20%	....	3.12	3.10	3.26	2.07	....
Seconds......	10%	....	1.49	1.39	....	.99	....
Yellow Cling Sliced							
S. Extras.....	60%	....	....	9.75	11.59	7.59	....
Extras.......	50%	6.76	9.95	7.38	9.23	6.53	....
E. Stands....	40%	3.30	8.89	5.85	6.20	4.55	....
Standards....	30%	3.27	4.87	3.79	4.85	2.90	....
Seconds......	....	....	3.11	2.29	....	1.95	....

PREPARATION OF THE SYRUP

In general, the syrup is prepared in a large tank. The sugar and water are boiled by a current of steam. When the foam which appears at the surface of the boiling syrup goes down to the bottom of the tank, it is ready to be racked into other tanks, in which it is diluted to the required gravity. The syrup before being sent to the syruping machine should be carefully filtered. In this way it will show a bright color and consequently a good appearance in the cans. As it is very expensive to prepare the different degrees of syrups at 60° F., the following correcting tables for syrup are used:

TABLE No. 20

Table for Correcting Reading of Saccharometer at Different Temperatures

Temp. Fahr.	5°	10°	15°	20°	25°	30°	35°	40°	50°	60°	70°	75°
	Corrections to be subtracted to degrees Saccharometer											
32..	.30	.41	.52	.62	.72	.82	.92	.98	1.11	1.22	1.25	1.29
41..	.30	.37	.44	.52	.59	.65	.72	.75	.80	.88	.91	.94
50..	.26	.29	.33	.36	.39	.42	.45	.49	.50	.54	.58	.61
54..	.20	.22	.24	.26	.29	.31	.33	.34	.36	.40	.42	.46
57..	.15	.16	.17	.18	.19	.21	.22	.22	.23	.26	.28	.32
61..	.07	.08	.09	.10	.10	.11	.12	.12	.12	.14	.16	.18
62..	.02	.03	.03	.03	.04	.04	.04	.04	.04	.05	.05	.06
	Corrections to be added from degrees Saccharometer											
64..	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.02
68..	.08	.08	.09	.09	.10	.10	.10	.10	.10	.10	.08	.06
72..	.26	.29	.31	.31	.32	.32	.32	.33	.34	.32	.29	.25
75..	.38	.41	.43	.44	.46	.46	.47	.47	.50	.46	.43	.40
79..	.50	.54	.56	.58	.60	.61	.62	.62	.66	.62	.58	.55
82..	.64	.68	.70	.72	.76	.76	.78	.78	.82	.78	.72	.70
86..	.78	.82	.87	.92	.92	.94	.94	.98	.94	.88	.88	.86
90..	.93	.98	1.01	1.03	1.08	1.08	1.10	1.10	1.14	1.10	1.03	.98
93..	1.09	1.14	1.16	1.21	1.24	1.24	1.26	1.28	1.30	1.26	1.19	1.17
97..	1.25	1.32	1.33	1.38	1.41	1.41	1.44	1.46	1.47	1.42	1.35	1.33
100..	1.43	1.49	1.51	1.55	1.59	1.59	1.62	1.64	1.65	1.60	1.51	.49
104..	1.61	1.67	1.71	1.73	1.79	1.79	1.80	1.82	1.83	1.78	1.69	1.65
108..	1.80	1.86	1.89	1.93	1.99	1.99	2.00	2.00	2.01	1.96	1.85	1.81
110..	1.90	1.96	1.99	2.03	2.09	2.09	2.10	2.10	2.10	2.05	1.93	1.89
112..	2.00	2.06	2.09	2.13	2.19	2.19	2.20	2.20	2.19	2.14	2.02	1.97
115..	2.21	2.27	2.30	2.34	2.39	2.39	2.40	2.40	2.39	2.32	2.20	2.25
117..	2.32	2.38	2.41	2.45	2.49	2.49	2.50	2.50	2.49	2.41	2.29	2.24
119..	2.43	2.49	2.52	2.56	2.59	2.59	2.60	2.60	2.59	2.50	2.38	2.23
121..	2.54	2.60	2.63	2.67	2.69	2.69	2.70	2.70	2.69	2.60	2.47	2.42
122..	2.65	2.71	2.74	2.78	2.80	2.80	2.80	2.80	2.79	2.70	2.56	2.51
124..	2.77	2.81	2.84	2.89	2.90	2.90	2.90	2.91	2.89	2.80	2.65	2.60
126..	2.89	2.92	2.94	3.00	3.01	3.01	3.01	3.02	2.99	2.90	2.74	2.69
128..	3.01	3.03	3.04	3.11	3.12	3.12	3.12	3.13	3.09	3.00	2.83	2.78
130..	3.13	3.14	3.15	3.22	3.23	3.23	3.23	3.24	3.19	3.10	2.92	2.87
131..	3.25	3.26	3.26	3.33	3.33	3.33	3.35	3.29	3.70	3.70	3.00	2.96
133..	3.38	3.39	3.39	3.44	3.44	3.44	3.44	3.46	3.39	3.30	3.09	3.05
135..	3.51	3.52	3.52	3.55	3.55	3.55	3.55	3.57	3.49	3.40	3.18	3.14
137..	3.63	3.64	3.64	3.66	3.66	3.66	3.66	3.68	3.60	3.50	3.27	3.23
139..	3.75	3.76	3.76	3.77	3.77	3.77	3.77	3.79	3.71	3.60	3.35	3.32
140..	3.87	3.82	3.88	3.88	3.88	3.88	3.88	3.90	3.82	3.70	3.43	3.41
149..	4.52	4.53	4.54	4.51	4.51	4.49	4.48	4.48	4.36	4.21	3.95	3.88
158..	3.17	5.18	5.20	5.14	5.13	5.10	5.08	5.06	4.90	4.32	4.47	4.35
167..	...	6.00	5.90	5.84	5.79	5.74	5.74	5.66	5.48	5.27	4.99	4.84
176..	...	6.62	6.59	6.54	6.46	6.38	6.40	6.26	6.06	6.82	5.50	5.33
185..	...	7.44	7.38	7.30	7.21	7.10	7.00	6.92	6.68	6.39	6.04	5.85
194..	...	8.26	8.16	8.06	7.97	7.85	7.71	7.58	7.30	6.96	6.58	6.37
203..	...	9.14	9.02	8.89	8.77	8.61	8.46	8.35	7.97	7.59	7.17	6.90
212..	...	10.01	9.87	9.72	9.56	9.39	9.21	9.03	8.64	8.22	7.76	7.42

USE OF THE TABLE

To use the table, the apparent sugar per cent of the syrup is determined by a spindle and the temperature is taken. Opposite the indicated temperature and in the column below the indicated sugar per cent will be found the amount to be added or subtracted from the observed reading.

EXAMPLE:

Observed sugar, 50%

" temperature, 115° F.

Opposite 115° F. and below 50% is found 2.39. This is then added to 50%, making 52.39, the correct degree of the syrup.

The decrease in concentration of the syrup after the fruit has been cooked, or, in other words, "The cut-out of the syrup," as it is termed among canners, is shown in the following table:

DECREASE IN CONCENTRATION OF THE SYRUP OR, "CUT-OUT OF THE SYRUP," AFTER THE FRUIT HAS BEEN COOKED

Variety, Grade	Number of Tests Made	Con. of Original Syrup	Con. After Cooking Average	Average Decrease	Max. Decrease	Min. Decrease
Peaches						
Lovell						
S. Extras	12	50%	29%	20%	22%	19%
"	8	40	21	18	19	18
E. Stands	10	30	19¼	12	13	12
Standards	18	20	12	7	9	8
Nicholls						
S. Extras	19	50	26	23	22	19
"	16	40	20	19	18	17
Orange						
S. Extras	25	50	28	21	22	18
E. Stands	16	30	16	13	13½	12
Standards	21	20	15	4½	4	3
Sims						
S. Extras	19	50	25¼	21	23	20
"	16	40	21½	18	17	16
E. Stands	19	30	19¼	10	11	9
Standards	18	20	13	6	7	6
Phillips						
S. Extras	23	50	29½	19	20	18
"	17	40	21½	18	17	16
E. Stands	19	30	18	10	11½	10
Standards	16	20	14½	3½	5	4

DECREASE IN CONCENTRATION OF THE SYRUP, OR "CUT-OUT OF THE SYRUP," AFTER THE FRUIT HAS BEEN COOKED—*Continued.*

Variety, Grade	Number of Tests Made	Con. of Original Syrup	Con. After Cooking Average	Average Decrease	Max. Decrease	Min. Decrease
Tuskena						
S. Extras	19	50	24	25	24½	23
"	24	40	17	22	23	21
E. Stands	16	30	15½	13	14	12
Standards	27	20	15	4	4½	3
Pears						
Bartlett						
S. Extras	17	40	22½	17	16	15
"	18	30	21	8	8½	7
E. Stands	14	20	18	2½	2	1½
Standards	18	15	13	1½	2	1
Cherries						
Royal Ann						
S. Extras	14	38	27	10	9	7
"	17	28	22	5	6	4
E. Stands	19	18	16	1	1½	1
Standards	23	13	11	1	1	1
Apricots						
Blenheim						
S. Extras	19	50	36½	13	12	11½
"	22	40	35½	4	6	3½
E. Stands	17	30	16	13	12	11
Standards	24	20	15	4	4½	3
Moorpark						
S. Extras	24	50	33½	14	16	12
"	19	40	26	13	12	10
E. Stands	24	30	23½	6	7	5
Standards	29	20	17½	2	3	1
Strawberries						
Gardner						
S. Extras	23	50	26½	22	23	20
"	26	40	22	16	17	15
E. Stands	27	30	20	9	8	6

The data show that the concentrations of the various syrups decrease markedly during the cooking of the fruit. The decrease is greatest with syrups of high concentration; at low concentrations of syrup the decrease during cooking is small. The decrease is due to mixing of the fruit juice and the syrup, brought about by the breaking down of the fruit cells during cooking.

The final concentration then represents the average of the concentration of the sugar of the fruit juice and the syrup. This decrease during cooking is seen to be greater for peaches and strawberries than for cherries, apricots, or pears; hence, to obtain the same concentration after cooking, peaches and strawberries must receive a stronger syrup than the other fruits. The decrease will be dependent inversely on the ratio of the concentration of the juice of the fruit to that of the syrup and directly on the ratio of the volume of the fruit juice to the syrup. That is to say, the greater the concentration of the fruit juice in proportion to the syrup the less will be the decrease during cooking; while the greater the ratio of the volume of juice to syrup, the greater will be the decrease during cooking.

The total amounts of solids found in various kinds of fruits grown in different localities of the State of California are shown in the table given below:

Analysis of Acid and Total Solids of Fruits Used in a California Cannery—1913

Variety of Fruit	Locality	No. of Anal.	Ave. Acid as H_2SO_4	Ave. Total Solids	Max. Acid as H_2SO_4	Max. Solids	Min. Acid as H_2SO_4	Min. Solids
Apricots.....	Sunnyvale....	60	1.4	15.6	1.7	20.4	.96	12.1
"	Haywards.....	30	1.5	13.8	1.6	19.4	.84	6.4
Peaches.....	Sacramento...	40	.62	7.5	.67	8.6	.57	6.3
"	Sunnyvale....	40	.32	17.1	.33	17.5	.31	16.2
Pears.......	Sacramento...	30	.19	10.3	.20	10.5	.18	10.2
"	Sunnyvale....	30	.25	14.8	.27	19.5	.22	12.2

The analysis shows that locality has a marked effect on the composition of the juice of canning fruits. For example, pears from Sacramento were much lower in sugar than Sunnyvale pears and were also considerably lower in acid than Sunnyvale pears. Sacramento peaches were strikingly lower in sugar, but higher in acid than Sunnyvale peaches. Sunnyvale and Haywards apricots were approximately of the same composition, no doubt due to similarity of climatic conditions.

Great differences, especially as regards acid, are apparent in

composition of the different fruits. Peaches are seen to be much lower in acid than apricots, and pears much lower in acid than peaches.

The cans having been automatically syruped and exhausted are then sent on to what is termed the "Sanitary Capping Machine." There are a great many types of these machines in the United States, and any one desiring to install one can best communicate with any leading manufacturers or confer with any California canner, who will gladly recommend the best machine in his experience.

COOKING DEPARTMENT

The cans leaving the peeling or packing tables automatically pass through the syruping machine, and from the syruping machine automatically into an exhaust-box. The type of exhaust-box used in California is shown in Fig. 18, and the standard exhaust given to the various fruits is four minutes' exhaust at the rate of 31 to 35 cans per minute. The temperature inside of the exhaust-box varies from 180° F. to 200° F.

EXHAUSTING

The operation of exhausting is important for the following reasons: 1—To sterilize the product completely; the temperature inside of the exhaust-box is sufficient to destroy almost all kinds of microorganisms which might originate fermentation, and thereby cause damage to the products; 2—The operation expels the air, making a good vacuum; otherwise, when the cans are put in the large tanks containing water at 212° F. they may burst very easily, due to the pressure developed by the expansion of the included air. The machinery used to close the cans does its work automatically. This system of closing the cans has the following advantages: 1—Economy of labor; 2—It is unnecessary to puncture and reseal the caps of the cans to expel the air when the cans are in the hot bath, as was the practice in the old system.

The fruit having been syruped, exhausted, and capped, is ready for cooking. In California there are various methods of cooking—*i.e.*, the "Open Vats," the "Dixon Cooker," or the

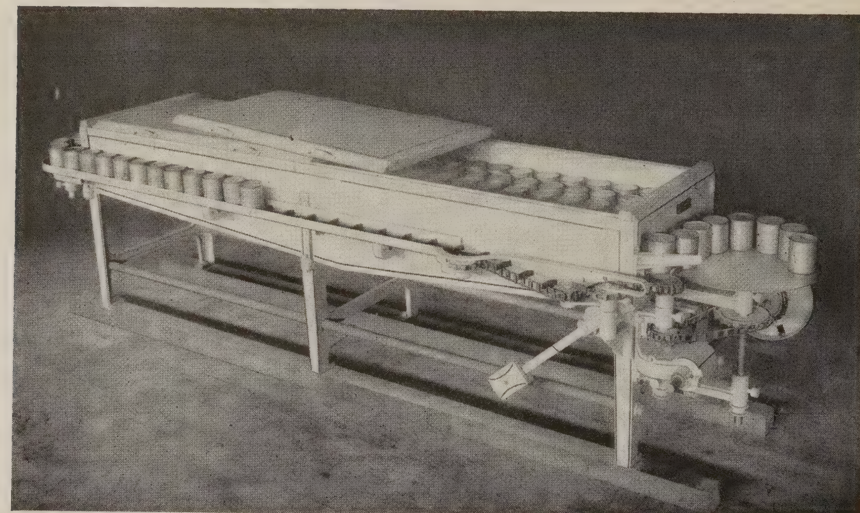


Fig. 18. Exhaust Box

SPECIFICATIONS

Size of Machine	Cans per Minute	Time of Exhaust	T. & L. Pulleys	Speed R.P.M.	Floor Space
3-run, 16 ft..	31	4 min.	2″ x 3″	167	2′ 2″ x 19′
5-run, 16 ft.	31	6½ min.	16″ x 3″	167	3′ 6″ x 19′
7-run, 16 ft.	31	8⅔ min.	16″ x 8″	167	3′ 10″ x 19′
5-run, gal. cans. . . .	15	8 min.	16″ x 3″	108	3′ 8″ x 16′

RULE FOR FIGURING SPEED OF EXHAUST BOX

No. 1 Tall cans—Attachment every second link, No. cans per min. $\times$ 3.6 = R.P.M.
No. 2½ and 3 cans—Attachment every third link, No. cans per min. $\times$ 5.4 = R.P.M.
No. 8 and 10 cans—Attachment every fourth link, No. cans per min. $\times$ 7.2 = R.P.M.

"Continuous Agitating Cooker." (Fig. 19.) Where the canneries are small, they use the Open Vats, on an average about four vats—two for cooking and two for exhausting. Where the cannery is of larger size, they use what is called the "Dixon Cooker,"

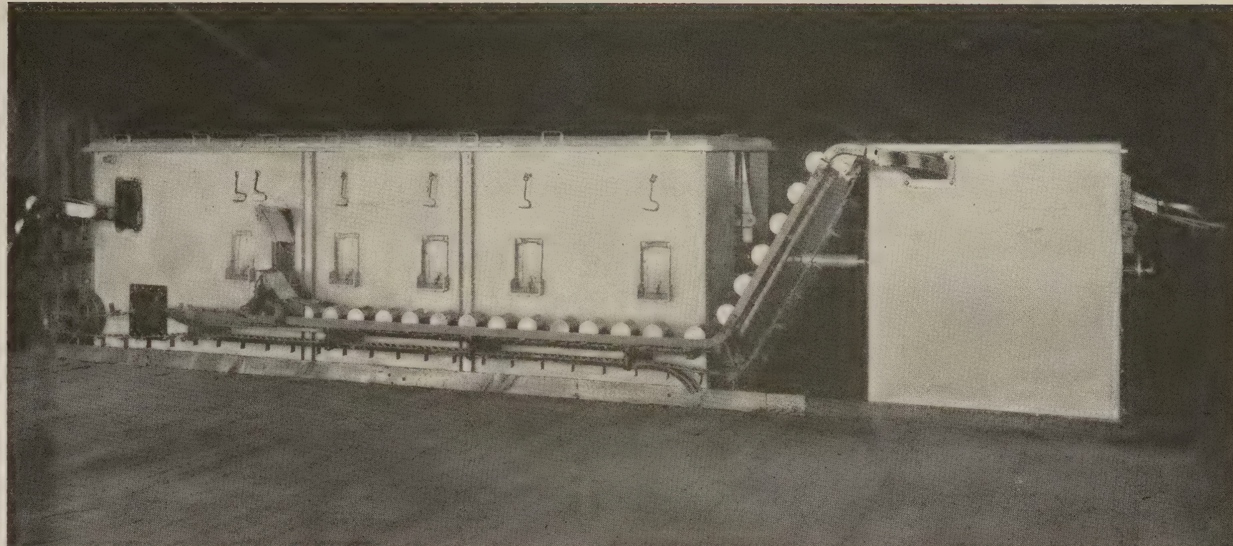


FIG. 19. Continuous Agitating Cooker and Cooler

SPECIFICATIONS

Size of Cans	Cans Held at One Time	Capacity per min. 20 min. Cook	Pulleys T. & L.	Speed R.P.M.	Floor Space
No. 1	600	30	12″ x 3″	66	5′ x 9′
Nos. 2 and 2½	600	30	12″ x 3″	92	5′ x 15′
Nos. 2½ and 3	600	30	12″ x 3″	96	5′ x 16′
Nos. 8 and 10	380	19	12″ x 3″	76	5′ 4″ x 17′

RULES FOR FIGURING SPEED OF COOKER

No. 1—
Number of cans per min. × 2.22 equals R.P.M.

Nos. 2 and 2½—
Number of cans per min. × 3.08 equals R.P.M.

Nos. 2½ and 3—
Number of cans per min. × 3.02 equals R.P.M.

Nos. 8 and 10—
Number of cans per min. × 4 equals R.P.M.

and on this cooker it is possible to cook fruit for varying lengths of time, from a few minutes up to twenty-five and thirty-five minutes. This cooker is shown in Fig. 20.

When the cans are sealed, they are put on trays holding 96 cans of 2½ size, or 165 cans of No. 1 size, and are carried to the hot bath. In some canneries small iron trays are used, which are placed in a larger one before being sent to the cooking-baths.

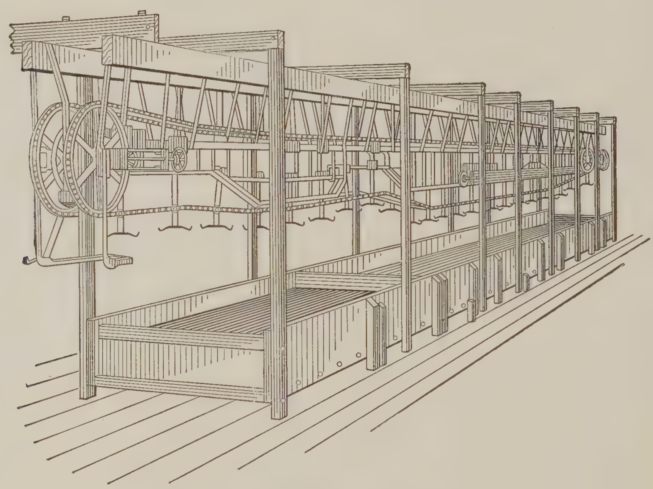


FIG. 20. Dixon Cooker

PROCESSING

The cooking of the fruit is performed in several ways: (a) Using steam cookers, (b) Using the Dixon Cooker, (c) Using tanks of hot water.

It may be said that all of these methods of cooking are good, but each method has its own advocates. By using steam-boxes and tanks of hot water, the cooking of the fruit becomes more economical. By using steam-boxes a great saving of steam is accomplished, because the boxes are closed and a very small amount of heat is wasted. The same is true when using tanks of hot water, for the reason that the surface exposed to the

air is relatively small, and the water can be kept at an even temperature during the whole day.

The Dixon Cooker is a good machine for cooking, but has the inconvenience of a large surface exposed to the air, and, therefore, there is a great waste of steam. Besides this, it is quite hard to keep an even temperature all through.

In general, we can say that there are both advantages and disadvantages in using a definite type of cooking-machine, but as a rule they become useful providing a good control of the temperature is exercised all the time. We have to understand once and for all that the operations of cooking are the most important features of the canning industry.

Working on a great scale, the processing of the fruit by the discontinuous method would be to a certain extent uneconomical, but the possibility of securing a high-grade product from the commercial point of view cannot be doubted. By using this system of cooking the fruit is given a better flavor and is rendered more palatable. Further, the microorganisms that escape the action of the temperature used during the first operation of cooking can be easily destroyed during the second processing, on account of their weakened condition. This indicates the benefits of using the discontinuous system of processing. It will also decrease the percentage of swelled cans commonly found in all canneries.

The actual system of cooking cannot be called a bad one, but the results would be better if the sanitary conditions under which the different steps of the canning of fruit are taken were carried to their highest degree of perfection.

In general, the duration of the hot bath depends upon the condition of ripeness of the fruit. The best system to follow in order to ascertain the duration of the hot bath is to make a careful examination of the fruit previous to canning. This is an important factor and should be emphasized. We know that the degree of ripeness of the fruit varies with the methods of cultivation and with the time at which it is gathered. Another way of determining the time that the fruit should be cooked

is by processing three or four cans at the same temperature, but during different lengths of time. In this way, by examining the condition of the fruit after cooking, the length of time to be used can be easily ascertained. This operation should be practised as often as it proves necessary. These facts show that the work done in this department is one of the most important operations performed in a cannery, and that in order to succeed it is necessary to place in charge of it a man of large experience.

The following tables give an idea of the temperature of exhausting and cooking different fruits:

TABLE No. 21

COOKING TEMPERATURES

Apricots

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
2½.......	Green....	190° F.	3 min.	212° F.	14 min.	Moorpark
2½.......	"	190	3 "	212	20 "	Blenheim
2½.......	Medium..	190	3 "	212	10 "	Moorpark
2½.......	" ..	190	3 "	212	8 "	Blenheim
2½.......	Soft......	190	3 "	212	8 "	Moorpark
2½.......	"	190	3 "	212	6 "	Blenheim
2½.......	Pie.......	190	3 "	212	18 "	Moorpark
2½.......	"	190	3 "	212	10 "	Blenheim

TABLE No. 22

Peaches

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
2½.......	Medium..	190° F.	3 min.	212° F.	20 min.	Tuskena
2½.......	" ..	190	3 "	212	15 "	Muir
2½.......	" ..	190	3 "	212	15 "	Crawford
2½.......	" ..	190	3 "	212	18 "	Orange
2½.......	" ..	190	3 "	212	21 "	Nicholl
2½.......	" ..	190	3 "	212	33 "	Phillips
2½.......	Green....	190	3 "	212	16.40 "	Tuskena
2½.......	"	190	3 "	212	18.20 "	Muir
2½.......	"	190	3 "	212	18.20 "	Crawford
2½.......	"	190	3 "	212	30 "	Orange

TABLE No. 22—*Continued*

Peaches

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
2½	Green....	190° F.	3 min.	212° F.	30 min.	Nicholl
2½	"	190	3 "	212	33 "	Phillips
2½	Soft......	190	3 "	212	12 "	Tuskena
2½	"	190	3 "	212	12 "	Muir
2½	"	190	3 "	212	12 "	Crawford
2½	Pie......	206	7 "	212	35 "	Tuskena
2½	Water....	206	7 "	212	30 "	"
2½	Sliced....	200	4 "	212	28 "	"
2½	"	200	4 "	212	35 "	"
2½	"	200	4 "	212	40 "	Phillips

TABLE No. 23

Pears

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
2½	Medium..	190° F.	4 min.	212° F.	25 min.	Bartlett
8	" ..	190	7 "	212	16 "	"
2	" ..	190	4 "	212	12.30 "	"
1	" ..	190	4 "	212	12.30 "	"
2½	Green....	190	4 "	212	35 "	"
8	Pie......	190	7 "	212	35 "	"
8	Water....	190	7 "	212	50 "	"
2½	Pie......	190	7 "	212	15.40 "	"

TABLE No. 24

Strawberries

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
2	Medium..	190° F.	3 min.	212° F.	14–16 m.	....

TABLE No. 25

Cherries

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
2½	Medium..	190° F.	3 min.	212° F.	18 min.	Royal Ann
1	" ..	190	3 "	212	15 "	B. Tartarian

TABLE No. 26

Blackberries

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
2.........	Medium..	190° F.	3 min.	212° F.	13–16 m.	....

TABLE No. 27

Grapes

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
2½.......	Medium..	190° F.	3 min.	212° F.	14–16 m.	....

TABLE No. 28

Plums

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
2½.......	Medium..	190° F.	3 min.	212° F.	14 min.	Washington
2½.......	" ..	190	3 "	212	16 "	Green-gage
2½.......	" ..	190	3 "	212	16 "	Egg
8.........	" ..	190	7 "	212	16 "	Green-gage

TABLE No. 29

Apples

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
10........	Medium..	190° F.	3 min.	212° F.	10 min.	....

TABLE No. 30

Gooseberries

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
3.........	Medium..	190° F.	3 min.	212° F.	12 min.	....

TABLE No. 31

Raspberries

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
2.........	Medium..	190° F.	3 min.	212° F.	12 min.	....

TABLE No. 32

Loganberries

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
2.........	Medium..	190° F.	3 min.	212° F.	12 min.	....

TABLE No. 33

Quinces

Size of Cans	Condition of the Fruit	Exhausting		Cooking		Variety
		Temp.	Time	Temp.	Time	
10........	Medium..	190° F.	3 min.	212° F.	16 min.	....

It should be borne in mind that these figures cannot be taken as absolute, because they vary widely according to the facts already established.

The proper degree of cooking varies with the varieties of fruit under processing. We may illustrate this by taking peaches as a practical example. The proper degree of cooking is recognized when the samples opened in the sample room show the following characteristics:

(*a*) Uniform color over the whole surface.

(*b*) Softened texture within certain limits, but not too soft.

(*c*) The syrup must be bright without any particle of fruit, especially in the case of high commercial grades.

The proper texture of the fruit can be ascertained by using a spoon with which every piece of fruit under observation

should be tested. If the pieces of fruit are penetrated with the spoon, with light pressure, it will mean that they have received the proper degree of cooking. The same process should be undergone in testing other kinds of fruits.

COOLING

As soon as the cans have been cooked sufficiently, they must be quickly cooled in water, in order to decrease the action of the temperature on the fruit. The Dixon Cooker is provided

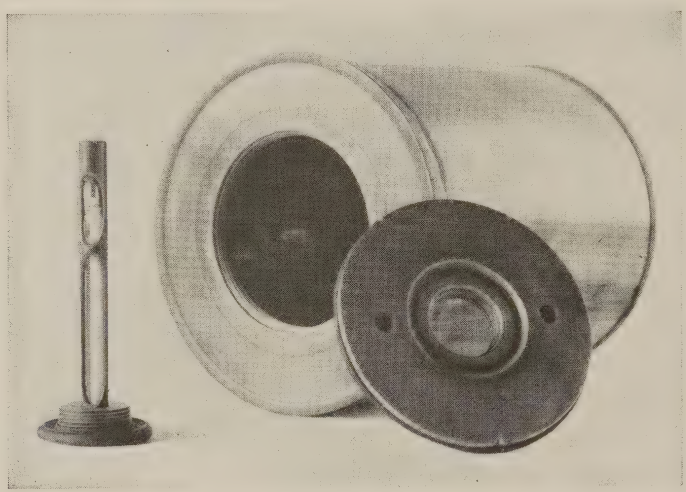


FIG. 21. Can Used for Testing Heat Penetrability
a. Self-register maximum thermometer
b. Can with screw top

with a tank containing cold water for this purpose. The cold water of the tank should be continually renewed, because it soon becomes warm. Some factories are furnished with special equipment in order to chill the cans immediately after they have been cooked, which consists of a shower where the cans receive a cool bath for three or four minutes. This method is much more rapid than the cooler used with the Dixon Cooker.

PENETRABILITY OF THE HEAT IN VARIOUS FRUITS

In order to know the different degrees of penetrability of the heat in various fruits during the operation of cooking, and, at the same time, the temperature registered at the center of the cans, we have performed experiments, the results of which are shown in the following table:

HEAT PENETRABILITY OF CANS

TABLE No. 34

Cherries

Size of Cans	Grade of Fruit	Exhausting		Cooking		Degrees		Penetrability at the Center of the Can
		Temp.	Time	Temp.	Time	Syrup	Time	
2½ .	S. Extras.	198° F.	4 min.	212° F.	16 min.	40%	16 min.	209° F.
2½ .	" .	198	4 "	212	16 "	40	30 "	212
2½ .	Extras....	198	4 "	212	16 "	30	16 "	209
2½ .	"	198	4 "	212	16 "	30	26 "	212
2½ .	E. Stand..	198	4 "	212	16 "	20	16 "	208
2½ .	" ..	198	4 "	212	16 "	20	24.5 "	212
2½ .	Standards	198	4 "	212	16 "	15	16 "	208
2½ .	" ..	198	4 "	212	16 "	15	23 "	212
2½ .	Seconds...	198	4 "	212	16 "	10	16 "	207
2½ .	" ...	198	4 "	212	16 "	10	35 "	212
1 . . .	E. Stand..	198	4 "	212	15 "	20	15 "	208
1 . . .	" ..	198	4 "	212	15 "	20	23 "	212
1 . . .	Stand....	198	4 "	212	15 "	15	15 "	209
1 . . .	"	198	4 "	212	15 "	15	24 "	212
1 . . .	Seconds...	198	4 "	212	15 "	10	15 "	209
1 . . .	" ...	198	4 "	212	15 "	10	23.5 "	212

TABLE No. 35

Apricots

Size of Cans	Grade of Fruit	Exhausting		Cooking		Degrees		Penetrability at the Center of the Can
		Temp.	Time	Temp.	Time	Syrup	Time	
2½ .	S. Extras.	198° F.	4 min.	212° F.	9 min.	50%	9 min.	204° F.
2½ .	" .	198	4 "	212	9 "	50	9 "	212
2½ .	E. Stand..	198	4 "	212	9 "	30	9 "	203
2½ .	" ..	198	4 "	212	9 "	30	9 "	212
2½ .	Standards	198	4 "	212	9 "	20	9 "	201
2½ .	"	198	4 "	212	9 "	20	9 "	212
2½ .	Seconds...	198	4 "	212	9 "	10	9 "	198
2½ .	" ...	198	4 "	212	9 "	10	9 "	212

TABLE No. 36

Peaches

Size of Cans	Grade of Fruit	Exhausting		Cooking		Degrees		Penetrability at the Center of the Can
		Temp.	Time	Temp.	Time	Syrup	Time	
2½ .	E. Stands	204° F.	4 min.	212° F.	6 min.	30%	6 min.	198° F.
2½ .	"	204	4 "	212	8 "	30	8 "	204
2½ .	"	204	4 "	212	9 "	30	9 "	205
2½ .	"	204	4 "	212	10 "	30	10 "	206
2½ .	"	204	4 "	212	15 "	30	15 "	207
2½ .	"	204	4 "	212	17 "	30	17 "	207
2½ .	"	204	4 "	212	18 "	30	18 "	207
2½ .	"	204	4 "	212	19 "	30	19 "	209
2½ .	"	204	4 "	212	20 "	30	20 "	209
2½ .	"	204	4 "	212	21 "	30	21 "	209
2½ .	"	204	4 "	212	24 "	30	24 "	209
2½ .	"	204	4 "	212	32 "	30	32 "	209
2½ .	"	204	4 "	212	40 "	30	40 "	212

TABLE No. 37

Pears

Size of Cans	Grade of Fruit	Exhausting		Cooking		Degrees		Penetrability at the Center of the Can
		Temp.	Time	Temp.	Time	Syrup	Time	
2½ .	Extras....	200° F.	4 min.	212° F.	5 min.	30%	5 min.	198° F.
2½ .	"	200	4 "	212	10 "	30	10 "	203
2½ .	"	200	4 "	212	12.3 "	30	12.3 "	205
2½ .	"	200	4 "	212	15 "	30	15 "	206
2½ .	"	200	4 "	212	20 "	30	20 "	207
2½ .	"	200	4 "	212	25 "	30	25 "	209
2½ .	"	200	4 "	212	30 "	30	30 "	209
2½ .	"	200	4 "	212	35 "	30	35 "	209
2½ .	"	200	4 "	212	42 "	30	42 "	212

By heat penetrability is meant the time necessary for the fruit in the center of the can to reach the temperature of the surrounding bath.

Observing these results, it will be noticed that the time required for the temperature to reach 212 deg. Fahr. at the center of the can varies with the varieties of fruits taken as examples. This phenomenon can be explained by the fact that

fruits differ greatly in heat conduction. Besides this, the concentration of the syrup used seems to exert a definite action upon the rapidity with which the heat will penetrate to the center of the can.

THE CANNERY WAREHOUSE

Before the cans are sent to the warehouse, they should remain on the platform for twenty-four hours, in order to give them time to cool, and to enable the inspector to discover any leaky cans. This work is performed by a well-experienced man who discovers the leaks by striking the cans with a small piece of iron or wood. After this, the cans pass through the lacquering machine, in which they receive a coating of paint to prevent rusting.

In this department, more than in any other, we have the opportunity of discovering all kinds of damaged cans, which may be due to a number of causes, the most common being the following:*

"Spoilage may result from insufficient processing, defective containers, or the use of unfit material. These losses are generally classed under the heads of swells, flat sours, and leaks. Formerly, losses were heavy at many factories, but these are becoming less each year, due to a better knowledge of what is necessary in material, handling, and improved appliances. More attention is paid to testing for bacteria, and greater care is taken in obtaining accurate thermometers and gauges, automatic temperature regulating devices, and time recorders, so that little is left to the judgment of the processor or helper.

"Spoilage due to insufficient processing is generally divided into two classes: swells and flat sours. In the former there is generation of gas, causing the ends of the can to become distended; in the latter, the contents of the can are sour, but there is nothing in the appearance of the can to enable the customer to determine the condition until the can is opened. Swells are generally due to under-processing good material, while flat sours most often result from giving the regular process to material which has been allowed to stand for some time, such as peas remaining in a load overnight, or corn left in a car or in a pile until it begins to heat. The raw material may show no evidence of fermentation on superficial examination, but this condition frequently exists under the conditions just cited. Swells are, therefore, more likely to be associated with rush operations, and flat sours with an overstock or delay in

*See Bulletin No. 151, U. S. D. A., by Dr. A. W. Bitting.

getting at the raw material. It is not intended to give the impression that swells and sours may not occur under other conditions, such as changes in the consistency of the corn, nor that swells may not occur in material which has stood, and sours result from under-processing, but only to state a general rule.

"Swelling or souring may take place shortly after processing, or the spoilage may be delayed for weeks or even months. Swelling is more likely to occur and be detected early, while souring is apt to be delayed, though it may occur early. The heat used in processing may have been insufficient to kill the vegetative forms or spores, but may have injured them to such an extent that time was necessary for recovery and subsequent development. A microscopic examination of the material a few days after processing, or of the incubating cans during a short period, might not show anything wrong. It is only by incubating samples for a number of days that early recognition may be made of some cases of spoilage, or possible spoilage. The canner often sends his goods from the factory with full confidence in their condition, and it is not until after they have been in the broker's warehouse or upon the grocer's shelves many weeks, or even months, that he becomes aware that anything is wrong. The spoilage may amount to only one can to the case, or the percentage may be high, but in either event the goods are rejected with loss.

"Spoilage from the use of improper material, *i.e.*, material which has been allowed to stand until fermentation has begun—is generally more or less sour to the smell and taste, but is sterile, the heat of processing having killed the bacteria.

"Can leaks may occur along the side, 'seam leaks'; at either end, 'end leaks'; at the cap, 'cap leaks'; at the tip, 'tip leaks'; or may be due to defective tin plate. Can-making has reached such a point of perfection that manufacturers guarantee all above two to the thousand. These imperfect cans are usually due to the solder not making a perfect union, or to defects in crimping or double seaming. With the use of the automatic canning- and tipping-machine there are fewer leaks than formerly occurred, when the work was done by hand; leaks in sanitary cans are generally due to poor adjustment of the rollers. Leaks are recognized as a rule by inspection in the hot bath, few getting into the wareroom."

As has been stated, the leaky cans are recognized after they have remained on the platform of the warehouse for twenty-four hours. The inspector is possessed of such skill that the sound produced by the cans when they are struck enables him to detect the leaky ones. In the hot bath, it is very difficult to recognize the leaky cans, due to the circumstance that the water being kept at boiling-point gives out a great number of bubbles which interferes with its detection. The hot bath is used in order to locate the leaks in those cans which have been returned to the cook-room. The water of the

bath in which the cans are heated to locate the leaks should never be kept at boiling temperature.

"Leaks may be very small, even microscopic in size, and therefore difficult to detect, or pieces of the can contents may be driven into the opening and seal it for the time. Leaks invariably cause swells. A check on spoilage can be kept by placing a few cans from each day's run in a room kept at a high temperature (98 degrees), as these will incubate much more rapidly than if kept in a storeroom.

"There are two conditions known to the trade as 'springers' and 'flippers.' A springer is a can the end of which will bulge slightly after a time, but on opening there is found neither gas nor spoilage, though the cans have the appearance of being swells. This condition has been found to be due to overfilling or to packing cold. Such goods when placed in a warm grocery will bulge, due to the temperature. A flipper is a springer of such mild character that the head may be drawn in by striking the can on a hard object. It is always possible to tell a swell from a springer by the use of a microscope, as in the former there will be a large number of organisms, while in the latter there will be very few."

A swelled can never can be drawn in by striking it on a hard object, and, if it is carefully observed, it will be noticed that on its edges there is not any leakage. On the other hand, in the case of a swelled can due to a leak, and especially when its contents have fermented, it will be observed that there is a leakage on its edges. The kinds of organisms that predominate in the former, and also in leaky cans, will be treated in more detail later.

"While a spoiled can of food should never be eaten, the danger of poisoning from fruits and most vegetables is very remote. Ptomaine or other poisons may form in meat, milk, and fish, but rarely, if ever, in vegetables.

"Canned foods may be injured by an excess of either heat or cold. Some products are injured more than others. The effect of prolonged heating is to cook the contents to a pulp. This is seen at times, in the case of peas and tomatoes in particular, when the cans have been stacked tightly before being fully cooled. The liquor will become cloudy from short heating, thick and heavy from prolonged heating, and the peas softened and broken if it is continued for a number of days. The writer has seen peas stacked that were warm for three weeks after packing. Tomatoes become soft and pulpy, and often turn a walnut brown if stacked hot and the heat is retained. All fruits become murky and lose their distinctive flavor and odor. Canned foods will stand the high temperature of summer very well, but as far as possible they

should not be placed in the hot sun nor kept in a very hot storeroom. The effect of moderate heat is not nearly so marked as might be expected.

"Cold seems to have no ill effect upon canned goods unless it goes below the freezing-point. Most canned foods will stand a little freezing without appreciable change. Repeated freezing and thawing cause the goods to become flabby and give a flat taste. In all cases the interior of the cans shows a distinct attack upon the tin. With fruits, the coating of the cans is made to appear as though it were galvanized. Canned fruits will resist a fair degree of heat or cold without serious injury, but continued heat or a very high temperature, or repeated freezing and thawing, will cause deterioration in quality.

"Foods properly prepared and kept under reasonably good conditions deteriorate very slowly, so that cans carried from one year to another may be as good as or better than the latest pack, depending upon the comparative quality of the fresh product used. On general principles, however, it is desirable that a product should not be carried over several seasons. The amount of tin dissolved also increases with time, which is an additional reason for not holding canned goods any longer than is absolutely necessary."

In this department the most important machines used are the following:

Can Lacquering Machine: This machine is employed in putting the golden lacquer on the cans; first, to prevent any

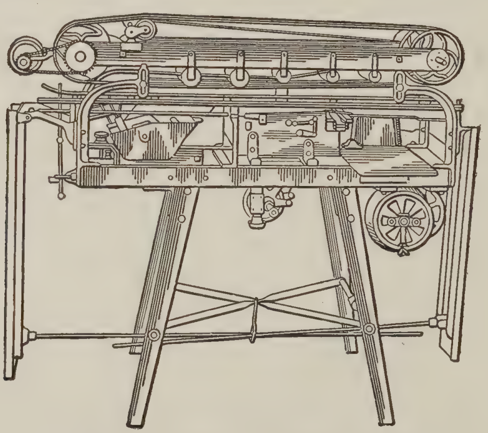


FIG. 22. Improved Labeling Machine

rust to the cans and consequent spoiling of the fruit, and second, to give the cans a desirable appearance.

The cans are now lacquered and put in a pile, and are next sent to the labeling machine, illustrated in Fig. 22.

The next department of importance in the cannery is the box department, where are made the boxes in which the cans are shipped. Here we have what is called the "box nailing machine," for making the boxes; also the "box branding machine," for branding or stenciling the names on the outside of the boxes.

A committee representing the Box Makers, working in connection with the United States Forest Products Laboratory, consulting with a committee from the American Society for Testing Material and the National Canners, has tested boxes of various materials, and of different methods of construction, and has recommended the following:

SPECIFICATION FOR CANNED FOOD BOXES MADE OF VENEER AND SAWED LUMBER, NAILED CONSTRUCTION

Boxes must be well manufactured from lumber which is sound (free from decay or dote), dry, and well seasoned. Lumber must be practically free from knot-holes, the loose or rotten ones not greater than 1 inch in diameter. No knots will be permitted which will interfere with the proper nailing of the box.

The principal woods used for boxes are, for the purposes of these specifications, grouped in three classes:

GROUP I

White Pine	Yellow Poplar	Magnolia	Redwood
Spruce	Balsam Fir	Noble Fir	Butternut
Aspen	Chestnut	Buckeye	Cucumber
Western Yellow Pine	Sugar Pine	White Fir	Alpine
Cottonwood	Willow	Cedar	Lodgepole Pine

Material, Ends

For No. 3 can boxes, ends not less than ⅝-inch full thickness, one or two pieces cleated. Or not less than ¾-inch full thickness, without cleats, one or two pieces. Uncleated two-piece ends fastened with three not less than ⅞ by ⅜-inch corrugated fasteners, two driven from one side and one from the opposite side.

For No. 2 can boxes, ends not less than ⅝-inch full thickness, one or two pieces. Uncleated two-piece ends fastened with three not less than ⅞ by

⅜-inch corrugated fasteners, two driven from one side and one from the opposite side.

Sides, Tops, and Bottoms

For No. 3 can boxes, sawed lumber, not less than ⅜-inch full thickness; not more than three pieces to each side, top or bottom, and no piece less than 2 inches in width.

For No. 2 can boxes, sawed lumber, not less than 5/16-inch full thickness, not more than two pieces to each side or top and not more than three pieces to the bottom, no piece less than 2 inches in width.

Cleating

Cleats 1⅛ by 5/16-inch or any other size cleat that has equally large cross-section with five nails to each cleat, driven through and clinched. No piece of end to have less than two nails. Outside nails driven as near the ends of cleats as is feasible. Balance of nails as evenly spaced as possible and no nail driven in a joint.

Nailing

Six nails on each nailing edge. Nails as evenly spaced as possible and no nail driven in a joint, all nails driven squarely into the center of the thickness of the end. Not less than two nails in each end of any piece.

Sides, tops and bottoms flush with the ends.

Size of nails, 6*d* standard cement coated box nails, not less than 1 13/16 inches in length.

Comment: The woods in this group are soft and require a large nail for proper holding.

GROUP II

Southern Yellow Pine   Hemlock   Douglas Fir   Cypress   Larch

Material, Ends

For No. 3 can boxes, ends not less than ⅝-inch full thickness, one or two pieces cleated. Or not less than 13/16 inch without cleats, one or two pieces. Uncleated two-piece ends fastened with three not less than ⅞ by ⅜-inch corrugated fasteners, two driven from one side and one from the opposite side.

For No. 2 can boxes, ends not less than ⅝-inch full thickness one or two pieces. Uncleated two-piece ends fastened with three not less than ⅞ by ⅜-inch corrugated fasteners, two driven from one side and one from the opposite side.

Sides, Tops, and Bottoms

For No. 3 can boxes, sawed lumber, not less than ⅜-inch full thickness; not more than three pieces to each side, top or bottom, and no piece less than 2 inches in width.

For No. 2 can boxes, sawed lumber, not less than 5/16-inch full thickness, not more than two pieces to each side or top and not more than three pieces to the bottom; no piece less than 2 inches in width.

Nailing

Six nails on each nailing edge. Nails as evenly spaced as possible and no nail driven in a joint, all nails driven squarely into the center of the thickness of the end. Not less than two nails in each end of any piece.

Sides, tops, and bottoms flush with the ends.

Size of nails, 5*d* standard cement coated box nails, not less than 1 9/16 inches in length.

Comment: The woods in this group are stronger but prone to split. The lighter nail will hold, but there should be no reduction in number.

GROUP III

Red Gum	Birch	Elm	Ash
Black Gum	Beech	Oak	Hickory
Maple	Tupelo	Sycamore	Hackberry

Material, Ends

For No. 3 can boxes, ends not less than ½-inch full thickness, one or two pieces cleated. Or not less than ⅝-inch full thickness; without cleats. Uncleated two-piece ends fastened with two not less than ⅞-inch by ⅜-inch corrugated fasteners.

For No. 2 can boxes, ends not less than ½-inch full thickness, one or two pieces. Uncleated two-piece ends fastened with two not less than ⅞-inch by ⅜-inch corrugated fasteners.

Sides, Tops, and Bottoms

For No. 3 can boxes, sawed lumber, not less than ⅜-inch full thickness, not more than three pieces to each side, top, or bottom, and no piece less than 2 inches in width, Gum Veneer not less than 5/16-inch thickness, one-piece sides and tops and not more than three-piece bottom, no piece less than 2 inches in width.

For No. 2 can box, sawed lumber, not less than 5/16-inch full thickness, not more than two pieces to each side or top, and not more than three pieces to a bottom, or Gum Veneer, not less than ¼-inch thickness, one-piece sides and tops, one- and two-piece bottom, no piece less than 2 inches in width.

Nailing

Six nails in each nailing edge. Nails as evenly spaced as possible and no nail driven in a joint, all nails driven squarely into the center of the thickness of the end. Not less than two nails in each end of any piece.

Sides, tops, and bottoms flush with the ends.

Size of nails: 4*d* Standard cement coated box nails—not less than 1 inch in length.

Comment: The wood in this group will hold nails well, the heads being pulled off before they will withdraw.

Lock Corner Construction

Group 1—No. 2 box— 7/16-inch full ends and sides—⅜-inch full top and bottom, or ½-inch full ends and ⅜-inch full sides, tops, and bottom. All

piecing tongued, grooved, and glued, tops and bottoms nailed with not less than twelve (12) 4*d* Standard cement coated nails in each top and each bottom.

No. 3 box—5/8-inch full ends—3/8-inch full sides, tops, and bottoms. All piecing tongued, grooved, and glued with not less than twelve (12) 5*d* Standard cement coated nails in each top and each bottom.

Group 2—No. 2 box—1/2-inch full ends—3/8-inch full sides, tops and bottoms. All piecings, tongued, grooved, and glued, nailed with not less than twelve (12) 4*d* Standard cement coated nails in each top and each bottom.

No. 3 box—5/8-inch full ends—3/8-inch full sides, tops, and bottoms. All piecings tongued, grooved, and glued, top and bottom nailed with not less than twelve (12) 5*d* Standard cement coated nails in each top and each bottom.

Group 3—No. 2 box 1/2-inch full ends— 5/16-inch full sides, tops and bottoms. All piecings tongued, grooved, and squeezed, top and bottom nailed with not less than twelve 4*d* Standard cement coated nails in each top and each bottom.

No. 3 box—1/2-inch full ends—3/8-inch full sides, tops, and bottoms. All piecings tongued, grooved, and squeezed, top and bottom nailed with not less than twelve 4*d* Standard cement coated nails in each top and each bottom.

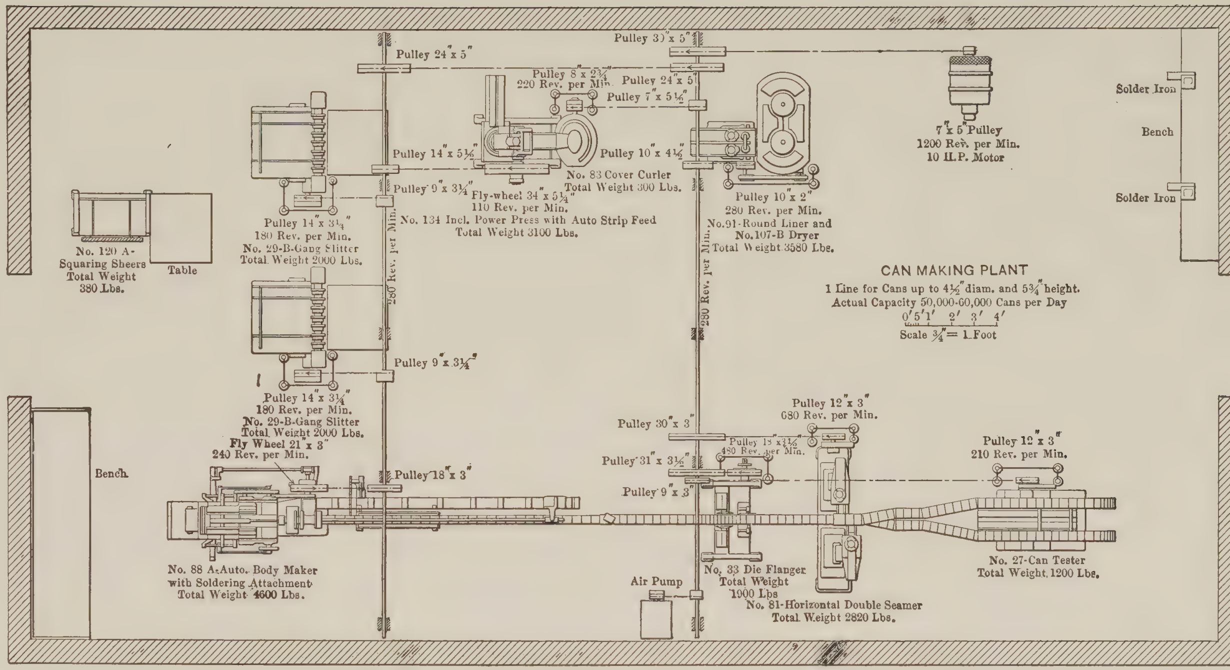
Specifications of other wood box construction withheld pending tests.

CANNING AND CAN-MAKING MACHINERY

The equipment of a canning plant is a problem in itself. There are so many details to be taken into consideration that it is very difficult to decide what that equipment should be.

We all know that the canning industry progresses year by year, and consequently the building of new machinery has to harmonize with the improvement of the canning methods.

The idea that we have had in inserting the following illustrations of the newest machines used in California canneries is only to assist the beginner to a knowledge of them. At the same time we wish to extend our thanks to those who have so kindly furnished us with these illustrations, among whom are Berger & Carter, of San Francisco, General Agents for the Max Ams Machine Co., of Bridgeport, Conn.; Anderson & Barngrover, of San José, Cal.; Huntley Manufac-



CAN MAKING PLANT
1 Line for Cans up to 4½" diam. and 5¾" height.
Actual Capacity 50,000-60,000 Cans per Day
0' 5' 1' 2' 3' 4'
Scale ¾" = 1 Foot
Pulley 24" x 5"
Pulley 30" x 5"
Pulley 8" x 2¾"
220 Rev. per Min.
Pulley 24" x 5"
Pulley 7" x 5½"
7" x 5" Pulley
1200 Rev. per Min.
10 H.P. Motor
Solder Iron
Bench
Solder Iron
Pulley 14" x 5½"
Pulley 10" x 4½"
No. 83 Cover Curler
Total Weight 300 Lbs.
Pulley 9" x 3¼"
Fly-wheel 34" x 5¼"
110 Rev. per Min.
No. 134 Incl. Power Press with Auto Strip Feed
Total Weight 3100 Lbs.
Pulley 10" x 2"
280 Rev. per Min.
No. 91-Round Liner and
No. 107-B Dryer
Total Weight 3580 Lbs.
280 Rev. per Min.
280 Rev. per Min.
Pulley 14" x 3¼"
180 Rev. per Min.
No. 29-B-Gang Slitter
Total Weight 2000 Lbs.
No. 120 A-
Squaring Sheers
Total Weight
380 Lbs.
Table
Pulley 9" x 3¼"
Pulley 14" x 3¼"
180 Rev. per Min.
No. 29-B-Gang Slitter
Total Weight 2000 Lbs.
Fly Wheel 21" x 3"
240 Rev. per Min.
Bench
Pulley 18" x 3"
No. 88 A-Auto. Body Maker
with Soldering Attachment
Total Weight 4600 Lbs.
Pulley 30" x 3"
Pulley 31" x 3½"
Pulley 9" x 3"
Pulley 12" x 3"
680 Rev. per Min.
Pulley 15" x 3½"
480 Rev. per Min.
Pulley 12" x 3"
210 Rev. per Min.
No. 27-Can Tester
Total Weight 1200 Lbs.
Air Pump
No. 33 Die Flanger
Total Weight
1900 Lbs
No. 81-Horizontal Double Seamer
Total Weight 2820 Lbs.

turing Co., of Silver Creek, New York, and the Sinclair-Scott Co., of Baltimore, Md.

SECRETS OF SUCCESS IN CANNING

In general, the heavy losses that sometimes occur in a canning plant are due to the fact that the different manipulations involved in the process of canning are improperly performed. If we analyze the different factors that are the cause of the decomposition of canned fruits and vegetables, we will find that the most important are: (1) Use of unfit raw material; (2) use of unfit cans and glass jars; (3) carelessness in the matter of cleanliness; (4) overfilling of the cans; (5) carelessness in sealing the cans; (6) carelessness in cooking the cans. These factors will be discussed in a thorough but simple manner, so as to give a clear understanding of the influence that they exert in the canning industry.

By unfit raw material, we mean those fruits or vegetables which, due to one reason or another, are partially decomposed. The decomposition of fruits and vegetables is due to the action of very small organisms which can be classed into three groups: (*a*) molds; (*b*) yeasts; (*c*) bacteria. The effects of these organisms upon the fruits and vegetables become more noticeable when the temperature conditions favor their growth, and also when the decayed portions are allowed to remain in contact with the sound raw material.

These facts, considered in their true value, would be sufficient to prove the necessity of making a very careful selection of the raw material before it is canned. This task is very simple, and it certainly pays to have it done as well as possible, for it will help the canner a great deal in obtaining a better product and one with long-keeping qualities. A factor contributing to success is the blanching of the raw material before it is delivered to the canner, resulting in greatly improving the appearance of the finished product. The blanching may be done by using a tank or any other receptacle fitted for that purpose, filled

with hot water in which the raw material should be submerged for a few minutes.

The use of unfit cans and glass jars is a point to which every canner must give a great deal of attention. The making of tin cans has been improved, and, as a result of this improvement, we find that one of the greatest achievements of the industry is the sanitary enameled can. The advantages of the use of this type of can cannot be doubted. The danger of poisoning effects, due to the action of salts of lead, has been minimized to such an extent that now it is almost negligible.

The inspection of the cans before they are sealed is a procedure which by no means should be neglected. The time is coming when the machinery used for making the cans will reach such a high state of perfection in the matter of seaming that no allowances will be necessary for leaks due to imperfection on the side seaming of the cans. But as long as this matter remains to be solved, the inspection of the cans, to which we referred in a previous paragraph, should be accomplished before the cans are filled with fruit, if saving of money and time is the aim of the canner. The glass jars used in canning should be in all cases free of cracks which in time might break, due to lack of care in the matter of handling them or to differences in temperature. The rubbers should be new, and caps should be sound and well-fitting.

One of the most important features of the different steps involved in the operations of canning is that of the hygienic conditions under which the canning of fruits and vegetables is accomplished. The raw material after it is cut in pieces, for instance, has to be thoroughly washed. In this way, we will secure a better-looking product, especially when glass jars are used. Besides this, by using water of good quality in washing the fruit before it is canned, the number of organisms that usually come in contact with the raw material will be decreased, thereby facilitating the preservation of the fruit. The cans and glass jars, before being filled with fruit, should be carefully washed. The tables used for cutting the

fruit, and also all the outfit used in the various steps in canning, should be kept as clean as possible.

The cans and glass jars should be filled with fruit in such a way as to leave plenty of room for the syrup, and also to facilitate the sealing of them. If the cans are overfilled, the task of capping them is made difficult, especially when it is done by hand. Besides this, the danger of putting the fruit in contact with the acid and solder used for sealing is increased. The proper sealing of the cans is important, and the canner should take plenty of time to secure a good sealing. When this is done by hand, it requires the aid of experienced operators, otherwise small openings may be left, and, therefore, the action of the sterilizing bath will be of little value.

The last step in canning is the cooking of the raw material. This operation can be considered as one of the most momentous features of this industry. If the sterilizing process is neglected, the whole season's pack will be lost, no matter how carefully all previous work has been done. In order to facilitate the cooking of the fruit, it is necessary to have it classified according to degree of ripeness. If this has been properly done, much of the trouble connected with the cooking will be reduced to a minimum. The water used for cooking should always be kept at the boiling point. The length of time that the raw material should be cooked depends on the nature of the raw material itself.

It is a very difficult proposition to state the definite length of time to be used in the process of cooking, for the simple reason that it varies from one day to another. Then the best way to be followed, in order to ascertain the right time of cooking, is by making several tests during the day's run. The heat penetrability while cooking the fruit varies with the kind of fruits used, with the length of time, with the temperature of the cooking bath and, finally, with the concentration of the syrup. By heat penetrability is meant the time required to register at the center of the can the surrounding temperature. The higher the temperature registered at the center of the can

after a certain period of cooking, the less the danger of getting spoiled cans after this. One of the best methods to follow, in order to know when the fruit is thoroughly cooked, is to test the pieces contained in a can. If they show the same appearance in color, and also the same degree of hardness, it will prove that they have been cooked a proper length of time. If the fruit has been cooked during thirteen minutes, and it does not show any sign of damage due to an excess of cooking, it would be advisable to prolong the cooking two or three minutes more, providing this increase in the time of cooking would do no harm to the product. In this way, the probability of getting swelled cans due to under-processing will be less, and financial results therefore better.

The previous discussion deals with the practical methods of minimizing spoilage. A few words regarding the "germs" that cause spoilage after canning may be of interest. In general, organisms that occur in spoiled cans of fruit differ from those in spoiled cans of vegetables by being more easily killed by heating. The organisms in spoiled fruit are principally yeasts and molds, all killed below the temperature of boiling water. Those in swelled cans of peas, asparagus, etc., are usually of types of bacteria killed above the boiling point of water, and hence require heating under steam pressure. Their resistance is due to formation of spores, or "seeds," which are very hard to kill. If these are in the cans or on the vegetables, etc., they will multiply in the cans and spoil the vegetables if the temperature has been insufficient or the time too short.

Fruits contain a great deal of fruit acids that aid in sterilization or killing the germs by heat; vegetables are usually almost free from appreciable amounts of acid, making sterilization for this reason difficult. These facts explain why it is necessary to use extra precautions in sterilizing vegetables, and why fruits are easily sterilized. It also explains why spoilage of fruit is usually due to leaks through which yeasts, etc., gain entrance; while swelling is often due not to leaks, but to growth of bacteria that were sealed up in the cans and survived cooking. In

sterilizing fruit, then, one of the principal aims of cooking will be simply to render the fruit palatable and of the proper texture. If this is accomplished at the boiling temperature, the yeasts, molds, and bacteria on the fruit will be killed. If spoilage then results, it means defective and leaky containers. Vegetables, on the other hand, because of the resistant bacteria spores, must be cooked under pressure, not with the idea of cooking or rendering them palatable primarily, but with the idea of killing the bacteria that cause swelling and souring. If pressure cookers are not available for vegetables, repeated sterilization at 212 deg. Fahr. (the boiling point of water) may be used; that is, three heatings on three successive days. The effect of the heating is to injure or weaken such spores or organisms as are not destroyed in one operation, and by repeating a second or third time at intervals the desired result is accomplished at the boiling temperature.

By way of summary, it may be stated, spoilage is due chiefly to the action of "germs," or small living organisms, that decompose the canned goods. Their activity is favored by the following factors: Six defects mentioned at the opening of this article. The methods of keeping down spoilage consist in avoiding or controlling the above conditions.

BRIEF CONSIDERATION ON THE CANNING OF DIFFERENT FRUITS

Apples

The apples used for canning should be of those varieties that cook well, and of medium size. Apples have to be peeled and cored, either by hand or machinery, and cut into halves or quarters. The canning should be done as soon as possible, in order to avoid the browning of the apples, which is due to the action of an enzyme. In case this operation has to be delayed, the apples should be kept covered with water containing a little salt, which will help to keep the natural color of the apples.

The next step is that of sorting and canning according to quality.

The cans are filled with syrup whose concentration varies with the different grades packed, and this can be seen in Table No. 14, page 31.

The commercial grades of apples and the sizes of cans mostly used can be seen in the following table:

TABLE No. 38

Size of Cans	Grade	Weight of Contents
No. 3	Extras	22 to 23 oz.
No. 2½	Special	....
No. 2½	Extras	....
No. 2½	Extra Standards	....
No. 2½	Standards	....
No. 2½	Seconds	....
No. 2½	Water	....
No. 2½	Pie	....
No. 10 Extras	No. 3 Grade	....
No. 10 "	No. 2½ Grade	....
No. 10	Extra Standards	....
No. 10	Standards	....
No. 10	Water	....
No. 10	Pie	....
No. 10	Solid Pack Pie	....

Apricots

The varieties of apricots used in California canneries are the Blenheim, Royal, and Moorpark. Of all these varieties, the first two are better suited for canning, because they are of more uniform size, and the ripening process is more regular than that of the Moorpark. Besides this, the Moorpark has a tendency to crack, which is a disadvantage in the packing of high grades. Nevertheless, the flavor and the percentage of sugar of this variety are higher than that of the other two.

Apricots are cut in halves and pitted. In some cases, they are peeled by using a solution of caustic soda.

The grading for quality is done according to what has been mentioned on page 13. This grading is done by hand, while the grading for size is done by machinery. The different

diameters of the screens used for that purpose are as follows: 1⅜", 1½", 1⅝", 1¾", 1⅞".

In case of special orders, the apricots are sliced, and this is accomplished by machinery.

The different grades of syrups used for apricots are shown in Table No. 8, page 30.

The time of exhausting and processing varies according to the figures given in Table No. 21, page 46.

The commercial grades of apricots, and also the sizes of cans mostly used, are given below:

TABLE No. 39

Size of Cans	Grade
No. 1 Flat	Extras
No. 1 Flat	Standards
No. 1 Tall	Extra Standards
No. 1 Tall	Extras
No. 1 Tall	Standards
No. 1 Individual	Extras
14 Oz.	Picnic
No. 3	Extras
No. 2½	Special
No. 2½	Extras
No. 2½	Extra Standards
No. 2½	Standards
No. 2½	Seconds
No. 2½	Water
No. 2½	Pie
No. 10 Extras	No. 3 Grade
No. 10 Extras	No. 2½ Grade
No. 10	Extra Standards
No. 10	Standards
No. 10	Water
No. 10	Pie
No. 10	Solid Pack Pie

Besides these grades, there are sliced and peeled apricots packed in glass jars. The pomological characteristics of the varieties of apricots referred to in a previous paragraph are given below.

Blenheim.—A very good variety, above medium, oval, orange with a deep yellow, juicy and tolerably rich flesh.

Royal.—Fruit roundish, large, oval, slightly compressed, skin dull yellow with orange cheek, very faintly tinged with

red, and a shallow suture, flesh pale orange, firm and juicy, with a rich vinous flavor.

Moorpark.—Fruit large, roundish, about two inches and a quarter in diameter each way, rather larger on one side of the suture than on the other; skin orange in the shade, but deep orange or brownish red in the sun, marked with numerous dark specks and dots; flesh quite firm, bright orange, parting free from the stone, quite juicy, with a rich and luscious flavor, stone peculiarly perforated along the back, where a pin may be pushed through; kernel bitter.

The number of pieces contained in a can is given below:

Grade	Number of Pieces	Weight of Fruit Net, Ounces	Size of Cans
Special Extras	18 to 22	17 – 19	2½
Extras	23 to 25	17 – 19	2½
Extra Standards	26 to 30	17 – 19	2½
Standards	36 to 40	17 – 19	2½
Seconds	40 to 46	17 – 19	2½

Berries

Canned berries are becoming popular among consumers. In order to increase the demand on the markets, the canning operations should be performed as carefully as possible. Berries are very tender, and can be easily bruised. Therefore, the handling of them has to be done with great care. Otherwise considerable waste will occur, and the yield per ton of high grades will be low.

The operations of stemming and grading for quality are done by hand, due to the nature of the product itself.

The washing of the berries before they are put in the cans is always necessary, in order to free them from sand or grit.

Berries, in general, should be packed in enamel-lined cans. In this way the tin is not attacked so easily, as is the case with plain tin cans.

The concentration of the syrup used for the different grades is

shown in Table No. 13, page 31; Tables Nos. 15, 16, 17, page 31, and Table No. 18, page 31.

The exhausting and processing time can be seen in Tables Nos. 24, 26, 30, 31, and 32, pages 47, 48, 49.

The size of cans used are Nos. 2, 2½, and 10.

The commercial grades are the same as those of other fruits.

The rules of packing that have been described are applicable to blackberries, loganberries, raspberries, and strawberries.

The net weight of contents for cans No. 2½ varies from 18 to 21 ounces.

Cherries

The pomological characteristics of the varieties of cherries used for canning are given below.

Black Tartarian.—Fruit of the largest size, bright purplish black; flesh purplish, thick, juicy, very rich and delicious.

Black Bigarreau.—Large, heart-shaped, deep glossy black, very solid and firm, dark purple, moderately juicy.

Royal Ann.—A magnificent cherry of the largest size, pale yellow, becoming amber in shade, richly dotted and spotted with deep red, and with a bright red cheek; flesh very firm, juicy, and sweet.

The best variety of cherries, and also the one that commands better prices, is the Royal Ann. The black varieties always lose so much color during the process of cooking that the syrup becomes highly colored, and consequently of poor appearance.

Cherries are stemmed by hand, and the grading for size is done by machine. The openings of the screens are as follows: 11/16″, ¾″, 13/16″, ⅞″, and 1″.

Cherries should be carefully washed before they are packed. In some cases, cherries are pitted by machine before being canned.

References concerning syrups used with the different grades of cherries are given in Table No. 10, page 30.

The time of exhausting and processing can be seen in Table No. 25, page 47. The net weight of cherries contained in cans No. 2½ varies from 17 to 19 ounces.

The commercial grades of cherries are the same as those of other fruits.

Grapes

The variety of grapes mostly packed in California is the White Muscat of Alexandria.

The preparation of grapes before canning is similar to that of cherries. In case of fancy packs, grapes are seeded by hand.

Grading for size is done by machine, and the openings of the screens are as follows: 5/8″, 11/16″, 3/4″, 13/16″, and 7/8″.

The concentration of the syrup used in grapes is seen in Table No. 12, page 30. Exhausting and processing are done according to the figures given in Table No. 27, page 48.

The commercial grades of grapes are the same as those of cherries. The net weight for cans No. 2½ must be from 14 to 16 ounces.

Peaches

Peaches are submitted to more or less the same process of preparation as is used for apricots.

Sometimes peaches are peeled by hand, but in the majority of cases the peeling is done by the caustic-soda process.

Grading for size is done by machine, and the diameters of the screens are as follows: 1 7/8″, 2″, 2 1/8″, 2 1/4″, and 2 3/8″. The extra large pieces are sliced, otherwise the cans will contain very few pieces. This is especially true in the case of No. 2½ cans.

The pomological characteristics of the best varieties of peaches used for canning are given below.

Cling-Stone Varieties

Tuskena.—Very large, roundish or roundish oval; color yellow with dark red cheek and bloom, cavity narrow and deep; suture extends past the apex. Flesh yellow with red at pit, juicy, vinous, rich, very good; pit not free.

Phillip's Cling.—Fine large yellow cling, no color at pit, which is very small; exceedingly rich and high-colored. Ripens progressively so that picking can cover two weeks without falling from tree.

Orange Clingstone.—Large, round; suture distinctly marked and extending nearly around the fruit; no swelling at apex, deep orange color with red cheek; flesh yellow, firm, juicy with rich flavor.

Nichol's Orange Cling.—Large, yellow, with purple cheek; flesh yellow and good.

Free-Stone Varieties

Muir.—Fruit large to very large; perfect free stone; flesh clear yellow, very dense, rich and sweet; pit small.

Crawford.—Very large, oblong, swollen, point at the top prominent, suture shallow skin, yellow, rich and excellent; free stone.

Lovell.—Yellow free stone; size uniformly large, almost perfectly round; flesh fine, texture firm, solid, clear yellow to the pit.

The Tuskena variety has the tendency to become brown when canning is delayed. Among the free-stone varieties, Lovell is one of the best suited for canning. However, the washing process, after they have been in contact with the caustic soda, is to a certain extent made difficult.

The concentration of syrup used for different grades of peaches is shown in Table No. 7, page 29.

The time of exhausting and processing is given in Table No. 22, page 47.

The commercial grades and the sizes of cans used are the same as in the case of apricots. (See Table No. 39, page 68.)

The number of pieces contained in a can is given below:

Grade	Number of Pieces	Net Weight of Contents	Size of Cans
Special Extras	8 to 10	16 to 19 oz.	2½
Extras	10 " 12	16 " 19 "	2½
Extra Standards	12 " 14	16 " 19 "	2½
Standards	14 " 16	16 " 19 "	2½
Seconds	16 " 22	16 " 19 "	2½

Pears

Pears are peeled, cored, cut in halves, and graded by hand. All these operations should be done as quickly as possible. By proceeding in this manner, there is the possibility of securing a nice-finished product. If pears are left in contact with the air for a considerable length of time, they become brown. This difficulty can be partially avoided by covering the pears with water, in case canning has to be delayed.

The grading for size is very important and should be carefully controlled in order to obtain a uniform pack. Taking into consideration the size, Bartlett pears may be divided into two groups: (*a*) large, (*b*) small. The large ones are preferably packed in cans Nos. 2½, 3, and 10. The small ones in cans Nos. 1 and 2. Pears should be packed in this manner for no other reason than the number of pieces that can be held by the cans.

The syrup used for pears is given in Table No. 9, page 30.

One of the most important features of the canning of pears is that of cooling the cans after they have been processed. If this is neglected, the pears will show a pinkish color which will detract from their commercial value.

The time of exhausting and processing is given in Table No. 23, page 47.

The pomological characteristics of the varieties of pears used for canning are given below.

Bartlett.—Fruit large, smooth, clear yellow, sometimes with delicate flush; flesh white, fine grained, juicy, buttery, highly perfumed, vinous flavor.

Kieffer.—Large, oval, narrowing at both ends, but variable in shape, often roundish and nearly obtuse pyriform; color yellow with brighter shade in the sun; patches and netting of russet, and brown russet dots, often nearly covering the yellow ground; flesh whitish, somewhat coarse, juicy, half melting, sweet, only good. The Kieffer pear is a hard variety and for this reason is not used for canning to the same extent as the Bartlett.

Plums

The varieties of plums mostly used for canning are the Green Gage, Washington, and Yellow Egg, whose pomological characteristics are given below.

Green Gage.—Rather small, round, suture faint green, becoming yellowish green, usually with reddish brown dots and network at base; flesh pale green, melting, juicy, exceedingly rich, and flavor excellent.

Washington.—Very large, roundish oval, suture obscure, distinct at base, yellowish green, faintly marbled, often with pale red blush; flesh rather firm, sweet, mild, very rich and luscious; free from the pointed stone.

Yellow Egg.—Very large, oval, narrow at ends, necked at base, suture distinct; flesh firm, rather acid until fully ripe, and then sweet; adheres to the pointed stone.

Plums before being packed must be washed and sorted according to size. The grading for size is done by machinery which has screens with the following openings: 1″, 1¼″, 1½″, 1¾″, and 2″.

The concentration of the syrup used with the different grades which are the same as those of other fruits is given in Table No. 11, page 30.

The time of exhausting and processing varies according to the figures given in Table No. 28, page 48.

The number of pieces contained in a can is given below:

Grade	Number of Pieces	Net Weight of Contents	Size of Cans
Special Extras	7 to 9	16 to 18 oz.	2½
Extras	10 " 13	16 " 18 "	2½
Extra Standards	13 " 16	16 " 18 "	2½
Standards	17 " 20	16 " 18 "	2½
Seconds	20 " 24	16 " 18 "	2½

Green Olives

One of the first operations connected with the canning of olives is the extraction of the bitter principles they contain. This

constitutes at the same time one of the main factors that every canner should take into consideration if he aims to supply the market with a well-finished, palatable, commercial product.

There are several methods which may be employed to deprive them of this bitterness. The caustic lye treatment has given the best results in experiments carried on at the University of California * and is the one in general use by the commercial picklers and canners.

The principles involved in the canning of green olives are very simple and will now be discussed in detail.

Picking

The large size varieties such as Ascolano, Sevillano, Manzanillo, etc., are considered the most suitable for pickling and canning purposes. They should be picked after attaining full size, but before beginning to soften or darken in color. The picking operations should be done as carefully as possible to avoid unduly injuring the fruit.

Grading

As soon as the olives are delivered to the factory, they are graded according to variety and size.

As a rule three grades are made which are either called: No. 1, No. 2, and No. 3, or choice, extra-choice, and standard.

There are two reasons for this grading: First, for commercial purposes and second, to facilitate the lye treatment.

Another important step is the sorting according to quality, that is to say, the olives that have been slightly damaged during the previous operations should be put in a cheaper grade and those badly injured should be discarded entirely.

Washing

The olives while in transit from the orchard to the canning plant always collect a considerable amount of dirt which should be removed by thoroughly washing them in clean water.

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* Notes on the canning of green olives, by J. C. Cruess.

A berry washer of the latest type can be advantageously used for this purpose.

Lye Treatment

Of all the operations concerned with the pickling and canning of olives, the lye treatment is of the most consequence.

The final quality (appearance, flavor, and texture) of the finished product depends largely upon the care and thoroughness exercised by both the pickler and canner during this process.

A 3 per cent caustic solution (3 kilos of potassium hydroxid (KOH) per 100 liters of water) may be used for this purpose. The olives are left in this solution until the lye has penetrated the tissues to a desired depth.

As the lye penetrates the olive it causes a darkening of the tissues, so that at any time during the process the action of the lye can be easily determined by simply cutting into the flesh of the olive and noting the amount of darkened tissues. A still more accurate test may be made by treating the cut surface with phenolphthalein, which causes that part of the fruit penetrated by the KOH (potassium hydroxid) to turn pink. When the lye has penetrated about three-fourths of the distance to the pit, which requires from about 8 to 10 hours, the caustic solution should be drawn off and replaced immediately with fresh water. It is essential that the action of the caustic solution be immediately stopped as soon as it has reached the pit. If the action of the lye continues beyond this point it causes a softening of the flesh which is undesirable. On the other hand, if the treatment has been insufficient the olives retain some of their bitterness.

Experiments have shown that by removing the lye solution as soon as approximately three-fourths of the distance to the pit has been penetrated, the action of the caustic will continue throughout the remainder of the flesh.

During the lye treatment the olives should be exposed to the air as little as possible, as the oxygen of the air causes an un-

desirable darkening of the olives. This is especially true as long as they retain any of the caustic solution.

After the olives have been soaked in water for 4 or 5 hours, the water should be renewed. At the end of 24 hours the water is again changed. This renewal of the water is continued until all traces of lye have been removed. As a rule, from three to five changes are required. As soon as the lye has been washed out of the olives they are put into a 4 per cent salt brine solution in which they remain for 48 hours, when the concentration is increased to 6 per cent, and finally to 10 per cent. If the fruit is put directly into a 10 per cent solution, there is danger of causing injury, due to a shrinking of the flesh. The gradual increase in the concentration of the solution avoids this injury. After the olives have undergone this treatment they are ready for canning.

Canning

Before the olives are placed in the cans a certain amount of final grading is necessary. Those olives which have been injured during the processing should not be put in cans with the better grades, but should be canned separately, or if too badly damaged discarded entirely.

The concentration of the brine to be used in filling the cans varies from 5 to 10 per cent. The cans are filled with the olives and enough brine added to bring the level of the liquid almost to the top of the can. The cans are then exhausted for 5 to 10 minutes at 190 deg. Fahr., then sealed, and finally processed at 212 deg. Fahr. for from 15 to 20 minutes.

Processing at a higher temperature and for a longer period of time has proved to be injurious to the quality of the finished product. After processing, the cans should be chilled in order to avoid any further action of the heat.

PART TWO

VEGETABLE-CANNING

VEGETABLE-CANNING

THE operations involved in the process of canning vegetables are very simple and they may be summarized in three general principles: The use of sound raw material, the observation of a very strict hygienic procedure from beginning to end, and the maintenance of the proper temperature while cooking, in order that all the microorganisms that may have accumulated during the handling of the unprocessed material will be destroyed.

With these purposes in view, we will give a description of the different manipulations connected with the canning of the most important vegetables.

Asparagus

Asparagus canning is an industry which increases considerably every year in California.

The most important step involved in its canning will be described hereafter. The first operation is grading according to size, which is done by hand, the different grades being shown in the following table, which also shows the number of pieces contained in each can of the standard size No. 2.

TABLE No. 1

No. of Spears per Can	Grade
14	Giant
20 to 22	Mammoth
30 to 33	Large
40	Medium
50	Small

After grading, the spears are cut a little shorter than the length of the cans. They are then thoroughly washed with cool water to remove any dirt or grit which may adhere to them. Washing is followed by blanching, which is

FIG. 23. Asparagus Canning at Demonstration Cannery, National Canners' Association, P. P. I. E.

done in order to (*a*) complete the cleaning which was partly accomplished during the washing, (*b*) to give them the flexibility required for the succeeding operations, and to make the peeling process easier. The time required for blanching varies from 3½ to 5 minutes in boiling water. Immediately after blanching they should be submitted to the action of cool water for 2 or 3 minutes. Then the spears are lifted to the canning tables, where they are carefully cleaned, placed in the cans, and graded according to the following table, which shows the size of the standard cans and the color of the product.

TABLE No. 2

Size of Cans	Color		Commercial Grade
	White	Green	
2½ Square	White	Green	Giant
2½ "	"	"	Giant Peeled
2½ "	"	"	Mammoth
2½ "	"	"	Mammoth Peeled
2½ "	"	"	Large
2½ "	"	"	Large Peeled
2½ "	"	"	Medium
2½ "	"	"	Small
1 "	"	"	Tips Mammoth
1 "	"	"	Tips Large
1 "	"	"	Tips Medium
1 "	"	"	Tips Small
2 Tall Round	"	"	Mammoth
2 " "	"	"	Large
2 " "	"	"	Medium
2 " "	"	"	Small
2½ Square	—	—	Ungraded
1 Tall	—	—	Ungraded
2 "	—	—	Salad Points
3 Round	—	—	Soup Tips
2½ "	—	—	Soup Tips
10 "	—	—	Soup Tips

What are known as Asparagus Tips are put in cans just one-half the regular size, and about 30 per cent more stalks are required to fill the cans.

After the cans are filled with asparagus and the right quantity of brine, whose concentration varies from 1½ to 2 per cent, is added, the cans are processed according to the following figures:

TABLE No. 3

Size of Cans	Exhausting		Processing	
	Time	Temp.	Time	Temp.
No. 2	3 min.	200° F.	10 min.	240° F.
No. 2½	3 "	200	12 "	240
No. 3	3 "	200	15 "	240

After the cans have been processed they should be cooled. Asparagus tips are processed as follows:

TABLE No. 4

Size of Cans	Exhausting		Processing	
	Time	Temp.	Time	Temp.
No. 1	3 min.	200° F.	12 min.	235° F.
No. 2	3 "	200	18 "	235
No. 3	3 "	200	25 "	235

In order to prepare asparagus for soup, proceed as follows: Thoroughly wash the stalks, place in ordinary kettle, cover with cold water, and boil for 25 minutes. Pour off the water and place on table or in some receptacle or box in which the asparagus may be pulped by using a potato masher or other means. Replace in kettle and add ½ pound of salt to each 15 gallons of pulp. Cook for 10 minutes, fill the cans, cap, and process as follows:

TABLE No. 5

Size of Cans	Processing	
	Time	Temp.
No. 2	8 min.	235° F.
No. 3	12 "	235
No. 10	25 "	235

String Beans

The bean used for canning purposes should be fresh and not wilted.

In case canning is delayed for any reason and the beans are already gathered, they can be put in fresh water for a time, which will restore their crispness.

The variety of stringless beans called Refugee is commonly used. Beans are graded as follows:

TABLE No. 6

Size	Grade
Up to 1½ inches	No. 1
From 1½ to 2½ inches	No. 2
From 2½ to 3½ inches	No. 3
Pods without any seeds showing in them	No. 4
Pods with small seeds showing in them	No. 5

The No. 5 grade is cut or broken into four or more pieces.

The next step is the blanching, which is done in the same manner as asparagus, and the length of time varies with the condition of the beans. After the beans are put in the cans, they are filled with brine whose concentration varies from 3 per cent to 5 per cent.

If the old style of cans is used, the brine should be hot. In case of sanitary cans they are exhausted 3 or 4 minutes at the temperature of 190 or 200 deg. Fahr.

The processing is done according to the following figures:

TABLE No. 7

Size of Cans	Grade	Processing	
		Time	Temp.
No. 2	No. 1	15 min.	240° F.
No. 2	No. 2	18 "	240
No. 2	No. 3	22 "	240
No. 2	No. 4	25 "	240
No. 2	No. 5	30 "	240

Beans in No. 10 cans should be processed 30 minutes longer than in No. 2 cans.

Lima Beans

Bean pods should be picked when a majority of the beans are fully grown or matured. Put through "Viner" or open by hand. The small green beans constitute Grade No. 1; the larger green beans, Grade No. 2, and the white ones, Grade No. 3.

Sort into three sizes or grades, wash in running cold water, and then blanch them in boiling water for 3 or 4 minutes. The beans should then be cooled off by placing them in cold water for a short time.

Place the beans in the cans and add the brine, made as follows: 2 pounds 6 ounces salt, 16 gallons water. After the cans are exhausted, they are processed according to the figures given below:

Size of Cans	Processing	
	Time	Temp.
No. 1 and No. 2 Grades	20 min.	235° F.
No. 3 Grade	30 "	235

Baked Beans with Pork

Select and clean pea beans (or navies) of recent growth, place 2 bushels in a 50-gallon barrel and nearly fill with a solution of 2 pounds of salt in 12½ gallons of water; soak 12 hours, then drain off surplus liquid. Old beans will require a soak of 18 to 24 hours, and usually an increase in time of process.

If the cost of the finished product will allow, place 1 bushel of beans in a 50-gallon barrel, nearly fill with the brine, and soak 4 to 8 hours, then draw off and replace with fresh brine and soak 4 to 8 hours, draw off this brine and cover beans with fresh water, soak 4 hours and drain. This removes much of the rank flavor and improves the finished product.

Slice salt pork (bellies) thinly and place in bottom of cans: No. 1 cans, ¼ ounce pork; No. 2 cans, ⅜ ounce pork; No. 3 cans, ½ ounce pork. Then fill cans ⅞ full of soaked beans and pour over same the following solution: 2½ pounds salt, 3 pounds sugar, 1½ pounds ground white pepper, ½ pint caramel (burnt sugar coloring), 12½ gallons water.

Due to the nature of this product it requires a long process, which is done as follows:

TABLE No. 8

Size of Cans	Processing	
	Time	Temp.
No. 1	2 hrs.	240° F.
No. 2	2½ "	240
No. 3	3 "	240

If a thick sauce is desired, thicken with 2½ to 3½ pounds cornstarch.

Tomato pulp may be used in place of the 12½ gallons water.

Following, we give one-fourth of the preceding formula, viz.: 16 quarts beans, ⅜ pound salt, ¾ pound sugar, 2 ounces ground white pepper, ⅛ pint caramel (burnt sugar coloring), 3⅛ gallons water.

Boston Baked Beans (Tomato Sauce)

To fill 1,000 No. 2 cans it will take 430 pounds navy beans. Divide this amount into three parts; put into three barrels (preferably having perforated galvanized bottom), cover with water and let stand 12 hours; then draw off water from the bottom of barrel.

Take beans from barrels, place in tinned cooker and cook in retort 60 minutes at 240 deg. Fahr. Fill 1 pint beans into each can and pour in sauce prepared as given below, to fill can within ½ inch of full.

Process No. 2 cans 1 hour at 250 deg. Fahr. To make sauce, take 32 gallons tomato pulp, 40 gallons water, 2½ gallons molasses. Boil water and molasses 5 minutes, 8 pounds creamery butter, 7 ounces ground cinnamon, 1¾ ounces cayenne pepper, and 40 pounds granulated sugar. This formula is for the best grade. Cheaper beans may be packed if one chooses by leaving out the butter and sugar, and using pulp made from waste tomato.

Boiled Cabbage

Clean off all outside green leaves, cut in quarters and remove all core, and, if the cabbage is very large and coarse, the large

midribs. Wash thoroughly in cold water, keeping a sharp lookout for worms. Blanch the cleaned cabbage in boiling water until it is thoroughly wilted, say 10 to 15 minutes, or place in cages in a retort and give 5 minutes at 240 deg. Fahr. Pack tightly in cans soon as cool enough to handle, fill with hot 3 per cent brine and process as follows:

Size of Cans	Processing	
	Time	Temp.
No. 3 cans	45 min.	240° F.
No. 10 cans	90 "	240

Cauliflower

Pick off outer leaves and cut stalk close to head, break apart and crisp in cold water; blanch 3 minutes in bath containing salt, 1½ pounds; water, 12½ gallons; place in cans, fill with hot brine (salt, 1½ pounds; water, 12½ gallons), and process as follows:

Size of Cans	Processing	
	Time	Temp.
No. 2 cans	12 min.	240° F.
No. 3 cans	15 "	240

Carrots in Butter

Prepare young and tender carrots by washing and scraping; blanch 3 or 4 minutes in boiling water, fill into No. 2 and No. 3 cans, pour over sauce made as follows: 2½ gallons water, 2 pounds sugar, 1 pound salt, 1 pound butter. Exhaust and process as follows:

Size of Cans	Processing	
	Time	Temp.
No. 2 cans	20 min.	240° F.
No. 3 cans	28 "	240

Celery

Cut the celery into pieces ¾ inch long. Place in a wire basket and let stand in cold water for 5 minutes. Plunge into

hot brine made of 1 pound salt to 12½ gallons of water. Let remain for 2 or 3 minutes. Fill into cans, pour over hot solution of salt made in the proportion of 2 pounds of salt to 12½ gallons of water. Process as follows:

Size of Cans	Processing	
	Time	Temp.
No. 2 cans	12 min.	240° F.
No. 3 cans	15 "	240
No. 10 cans	30 "	240

Corn

Before we go into the details connected with the canning of corn, we deem it of interest to quote here an article dealing with "Saving and Pedigreeing Seed Corn" by Richard Dickinson, of Eureka, Illinois:

"The proper care of seed is one of the most important and the most neglected of any process of the canning business. The enormous growth of the industry the past generation has made it difficult to give sufficient attention to the production of seed. Also, the old methods of saving seed are not sufficient for the large quantities now required. The result is that many canners have found it so difficult to produce high-grade seed that they have grown careless in this respect. In consequence, some canners buy all their seed, sometimes at great expense and frequently at much trouble, because they are unable to secure the same strain as that previously used. Buying is better, however, than such saving as that described by the proprietor of a large factory who said he always planted more corn than he expected to be able to pack, then whatever part matured too fast was left to stand for seed. When it was fully ripened in the field, it was shucked and hauled to the crib, and in the winter, when it was convenient, was shelled with a powder sheller.

"Such methods of saving seed corn help to keep up the old fallacy that seed corn which has been imported to any locality will tend to run down after a few years of its new environment. This belief is correct only to the extent that any seed tends to

vary in type and adjust itself to new climatic and soil conditions, unless care is used in the selection of the seed, so as to preserve the original characteristics. On the other hand, it is now the generally accepted belief of most field-corn breeders that seed corn imported from any considerable distance, especially if it undergoes a change of latitude, will take at least two or more years to become acclimated to make its best yield.

"Another phase of this belief is the idea that canned corn produced from seed grown in the East, especially in New England, will have better flavor than corn of the same variety grown in the same locality, canned in exactly the same manner, but produced from seed grown in the Central States. This claim has been challenged for some time by Western canners who grow their own seed, and during the coming season will be made the subject of experiments to determine from actual tests whether there is any difference in flavor due to the locality in which the seed corn is raised.

"In saving seed corn through most of the sections devoted to corn canning, the danger of frosts makes it always desirable and often necessary to gather the seed before it has fully matured in the field. On this account it must be dried after gathering, for which purpose some growers use racks or tie it up with strings. These methods will do for small handlers, but lack capacity for the canner. Some growers use a crib with tight sides and a false slatted floor through which air is forced by a blower for a week or more after storing the corn. But this has the disadvantage that the pressure of the ears touching each other prevents prompt drying and promotes mold at those points. This objection also applies to the custom of storing in crates, unless the crates are very shallow, in which case the capacity is limited. A much better method is to stick the ears up on pegs so that no two touch each other. Patented hangers are on the market for this purpose in the form of iron rods with wire points upon which the end of the cob may be stuck. A home-made appliance, which is cheaper and which has proved very satisfactory, is a strip of wood one by two inches inside and of as

great length as will hang from the ceiling of the seedhouse, into which tenpenny nails are driven from both sides at such an angle that when the strips are hung from one end the pointed end of the nail will make an angle of about seventy to eighty degrees with the vertical. The nails can be placed about three to four inches apart and the strips hung close together so that, with the ceiling about twelve to fourteen feet in height, corn can be stored at from fifty to one hundred ears to the square foot of floor space, and be thoroughly and satisfactorily dried.

"Artificial heat is desirable in damp or very cool weather; the temperature should not be allowed to fall much, if any, below fifty degrees until the corn is thoroughly dried.

"Of course, all moldy ears, nubbings, ears showing mixture of field corn and other undesirable types are previously culled out, so that the hangers are used only for good seed corn. It is good practice in gathering seed from the field to snap the ears off in the shuck, the same as for canning, and finish the husking at the seedhouse, in order to prevent shattering and bruising.

"When dry, the butt and tip of each ear should be shelled off, and the grains examined for mold or other imperfection which has not been apparent before. If the grains at both ends of the ear have a bright appearance, then shell the balance of the ear into a pan and look over the corn after being shelled. It is often possible in this way to reject an ear having moldy or blemished grains in the center which would otherwise have gone into the seed unnoticed.

"After shelling, the corn should be fanned with a strong blast, to take out chaffy and other light grains; then graded for size, so it will drop uniformly in the planter. As soon as shelling is well under way, test a few samples for germination, to see if your inspection was careful enough. If you find it difficult to secure a high percentage of germination by this method, then test each ear before shelling. There are various good systems and apparatus for doing this. Professor Holden, of the Iowa Experiment Station, has developed a very good one and is a strong advocate of this method of testing.

"The common practice of selecting seed at the shelling time, however, enables one to judge only as to the appearance of the ear. It gives no information in regard to the yield, the style of stalk, or the uniformity of quality or time of maturity of the ears produced.

"To determine these latter points some growers go into the field just before harvesting the crop and mark certain select ears, choosing the larger ears from hills having two or three stalks as probably of exceptional vigor; also, since the examination is made just at the time of ripening, it is possible to make a selection for uniformity of the time of maturity as well as for type of stalk and other characteristics of growth.

"This method of selection is founded on the tendency of sweet corn, like all other plants, to reproduce itself. It is well known, however, as anyone will notice when looking through a field, especially if he is selecting seed, that there is always a considerable tendency to vary from the type of the seed that was planted. These variations or 'sports,' as they are termed, are the basis for new strains and varieties, by taking advantage of desirable variations from the normal and propagating them for several generations with careful selection. This work, however, is the province of the seedsman rather than of the canner, and need not be dwelt upon here. The important point in this to the canner is that there is a very marked difference in the production of these variations by different ears. In fact, the difference in individuality of different ears is one of the most striking discoveries of the student of corn-breeding. An ear having every desirable characteristic will often produce a very small yield of undesirable ears, while a poorer appearing ear will show a large and uniformly desirable progeny.

"Some ears produce a variety of types, while others show a strong tendency to reproduce their own characteristics without variation. Having once secured a satisfactory type of seed, it is this latter quality that is desired. This inherent tendency is discovered and taken advantage of by what is called the 'ear to row' test. That is, plant selected ears embodying the de-

sired characteristics in a separate plat, one to each row, taking care that the soil is uniform and that the whole plat has absolutely uniform cultivation. In order to secure a uniform stand it is well to plant three or more grains to the hill, and after the corn is up thin out to two stalks per hill. During the growing season watch the manner of growth and character of stalks, the setting of the ears, and time of maturity. Finally, gather each row separately, and note the variation in yield and in the character of the ears produced as compared with the parent ear. Thus rows which show a poor habit of growth, unevenness in maturity, a poor yield, or a marked tendency to vary from the type of the parent ear, should be rejected entirely. From the rows showing high yield and uniformity in time of maturity, select the best ears, that is, those which are the nearest to the exact reproduction of the parent ear, and plant these in an 'ear to row' plat the next year. The balance of the ears in those desirable rows should be shelled up together and planted in a propagating or multiplying plat in order to produce seed for the general crop of the year after. The 'ear to row' plat should be planted in the center of this multiplying plat, as this has been proved by practice to be the most satisfactory way of isolating it from the pollen or other varieties of corn which might mix with it. The close proximity in one row of a number of plats, all grown from the same parent ear, creates a danger of inbreeding by self-pollenization, which is overcome by detasseling half of each row, alternating the ends, so that the half which bears tassels will pollenize the detasseled rows adjoining it. The tassels should be pulled out rather than cut or broken off, as the wound will bleed badly if made above the protecting leaves. It is good practice, likewise, to detassel all the weak, late stalks in or near the plat.

"The first year of the 'ear to row' test determines which of the ears planted has the power to transmit its own characteristics to its progeny. The next year's 'ear to row' test, using these ears which have inherited the parent ears' characteristics, will show which of them have also inherited from the parent ear

the power to transmit those characteristics to their progeny. Thus the continuation of the test for a term of years tends to eliminate the undesirable traits and to fix the desirable features, thus producing an improved and persistent type. Does this seem difficult to accomplish? It has been criticized as being a great deal of work with somewhat problematic results. It seemed so to me at first sight, but being dissatisfied with the limitations of our selection I concluded to try it. The first year I planted twenty of nearly identically uniform ears as I was able to select, and I was astonished at the results. To begin with, one row of the twenty showed a shorter but more rapid growth and matured from five to seven days before the balance. On gathering the crop I found a difference of yield ranging from seventeen and one-half pounds to thirty-two pounds of dry corn produced. The average being about twenty-six pounds, with a corresponding difference in the type of ears. One row showed a considerable mixture of field corn, no trace of which had appeared in the parent ear. The knowledge that the very best ears I could select had such wide difference in their inherited ability to reproduce their own good qualities decided my case in favor of a careful campaign to eliminate the poor ears.

"There has been a considerable study of the breeding of sweet corn seed by the experiment stations of Wisconsin, Maine, Maryland, and the National Department of Agriculture. The Illinois Station has made a very exhaustive study of the effects of breeding on the corn plant in general, and many of the results are of quite as much interest to the grower of sweet corn as of field corn. Their studies are also of interest in showing the remarkable results which may be obtained in a few generations by means of the 'ear to row' test. For example, in one experiment selection was made for varying the height of the ear above the ground, and in five years' selection the average height of one type was two feet one inch, while the average of the opposite type was five feet four inches. In another experiment, for varying the angle with the stalk at which the ear is borne,

it was possible in five years' selection to produce one type which stood at an angle of thirty-one degrees, while the opposite type showed an angle of one hundred and eleven degrees. Of course these two experiments are of no particular advantage to the grower of sweet corn, except as they show the possibilities of this system in determining which ears have the power to reproduce desirable characteristics and in fixing these characteristics permanently in the seed. The experiment regarding the angle at which the ears are borne is of interest also because it was found incidentally in these tests that the percentage of moldy and decayed ears was less than half as great in the declining as in the erect ears, due presumably to the better protection of the declining ears from the weather."

Those desiring to make a further study of this matter are referred to:

Bulletin No. 127, of the Bureau of Chemistry, U. S. Department of Agriculture.

Bulletin No. 415, Farmers' Bulletin, U. S. Department of Agriculture.

Bulletin No. 183, Maine Agricultural Experiment Station.

Bulletin No. 120, Maryland Agricultural Experiment Station.

Circular No. 18, Wisconsin Agricultural Experiment Station.

Bulletins Nos. 96, 119–128–132–148 of the Illinois Experiment Station.

Great care should be exercised in handling corn. It is preferable that the corn be taken from the stock in the morning, that is, the corn should be pulled or jerked from the stock with the husks on, and placed in baskets which are then gently emptied into the wagon box. It is very necessary to handle the corn carefully, so that it will not become bruised. As soon as sufficient quantity is picked for about one-half day's run, it is important to get it to the factory at once. If allowed to stand in the wagon for any length of time it is liable to heat and sour, especially in sultry weather.

No time should be lost after the corn is delivered at the factory before it is husked and silked.

It is necessary at all stages of the process of sweet corn to keep scrupulously clean everything that is used in connection with preparing it. The pans, knives, and everything that it comes in contact with should be washed with cold water and scalded with hot water or steam at least every two hours during the day. By paying attention to these details any one may successfully can this product.

Many make the mistake of pulling the corn in the evening, leaving it to set overnight before husking. In the morning it is cut from the cob and allowed to remain in a dish-pan or other vessel for two or three hours before it is placed in the cans. Fermentation will have started before the corn is subjected to the heat. It is then impossible to stop the fermentation either with steam or boiling water.

When received at the factory, husk the corn and separate the defective ears; trim and cut out worm-eaten places and remove all black and discolored spots; run through brushing machine to remove as much silk as possible, then through washing machine, then through cutting machine, then through silker, then into the mixer, where add the desired amount of syrup or brine; then into the cooker, where the temperature should be raised to 175 deg. Fahr. The syrup used for filling the cans is made in the following proportion: 3½ pounds dairy salt, 15 pounds cane granulated sugar, and 30 gallons water. When starting the filler after a shut-down, return the first few cans to the cooker. Corn must go into cans at a temperature as near 170 degrees as possible; if filled at a higher temperature, the cans will be slack when cold; if at a lower temperature, the process time must be increased. When work is once started, the operations should be continuous; it is especially necessary that it be kept constantly moving from the time it is placed in the cooker until it reaches the retort. After processing, cut cans frequently to detect darkening, slack, or overfilled cans. At the end of the day's work clean all machines thoroughly, removing every particle of corn and gummy matter, using a liberal quantity of hot water in which sal soda has been dissolved.

The cooking process is done at 250 deg. Fahr. for 40 minutes for cans No. 2. The cans after having been processed should be cooled.

It is necessary to cool the corn to keep it from turning brown; having been cooked at such a high temperature there is sufficient heat in the can to recook if not cooled at once. After cooling to about 150 to 160 degrees, there will be sufficient heat remaining in the can to dry it thoroughly, so it will not rust. The cans should then be stored in the warehouse and piled up, where they should remain at least two or three weeks in order to detect any swelled or spoiled cans, should there be any.

The corn standards as adopted by Ohio and Indiana Canners' Association are as follows:

Fancy.—Cans to be well filled; minimum gross weight, 23 ounces; absolutely young and tender stock; natural color; medium, moist and practically free from silk, cob, and husk.

Standard.—Cans well filled; minimum gross weight, 23 ounces; stock reasonably tender; free from hard particles, natural color.

Peas*

California canners have been devoting a great deal of attention to the canning of peas, and as a result of this we have at present a good product that can advantageously compete in quality with any of the foreign brands.

The varieties of peas mostly used for canning are the Little Gem, Alaska, Admiral, Advancers, and Horseford's Market Garden, of which the first two are early and smooth, and the others wrinkled. The wrinkled varieties are sweeter than the two first mentioned.

The methods of canning, the disposition of the machinery, and also the distribution of the work vary in different factories.

In general, we may say that after the raw material is hauled to the factory it goes through a simple process of preparation.

The peas are sent to the vining machine by the aid of a belt

* We take great pleasure in referring to the investigation made on the subject by Dr. A. W. Bitting.

or carrier. Here they are so separated from the pods that the tender ones are not injured in the least. After this they are submitted to the action of a fanning mill in order to remove pieces of pods, leaves, and dirt. Next comes the washing operation, which is done by means of wire cylinders in which the peas travel from one to the other, due to the inclined position given to the cylinders. In the meantime they are sprayed with pure cold water. A type of vining machine is shown in Fig. 24.

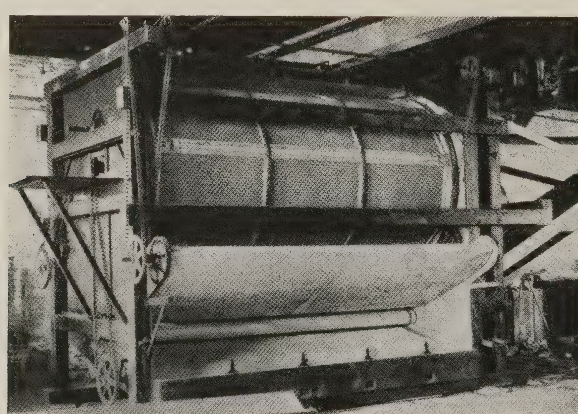

FIG. 24. Pea Viner

The grading of the peas according to size is accomplished by passing them over vibrating screens or cylinders. See Fig. 25.

The following table gives an idea of the size of mesh of the cylinders, and also of the commercial denominations given to the peas regarding size.

The marrowfat pass over the ends of the screens. Besides

TABLE No. 9

Grade	Opening Diameter
Petit Pois	Eighteen sixty-fourths inch hole
Extra Sifted	Twenty sixty-fourths inch hole
Sifted	Twenty-two sixty-fourths inch hole
Early June	Twenty-four sixty-fourths inch hole
Marrowfat	

these grades we have what is called the Telephone, and this name is given to late peas.

Some canners, instead of turning out all the mentioned sizes, combine two sizes in one.

In case of sweet wrinkled varieties of peas a twenty-six sixty-fourths-inch screen is used to separate the marrowfat, and those remaining above are classified as Telephone.

The above denominations, which refer to size and not to variety nor to time of gathering, have been partially taken from the French.

After the peas leave the graders they go over a belt which

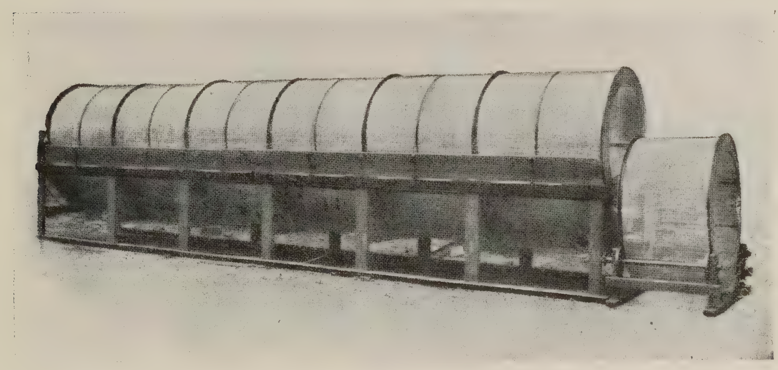

FIG. 25. Pea Grader

travels slowly, so as to give the help time to pick out the defective ones.

A very important operation which leads to great success in the canning of peas is the grading of them according to quality. The highest prices are paid for peas that show a high standard of tenderness and also a bright color. These results can only be obtained through careful grading. This operation is to a certain extent hampered, for the reason that the peas contained in one pod, for instance, do not show the same grade of maturity. We have, therefore, to find a method that will facilitate the accomplishment of the operation.

Brine solutions seem to solve the problem.

The strength of these solutions permits the separation of the peas into three different grades—that is to say, according to their degree of tenderness.

The first grade will float in a lighter solution than the second or third grades, for the reason that the latter are heavier than the former.

The appearance of these grades after they have been canned shows that the first one is lighter in color, softer on pressure, and

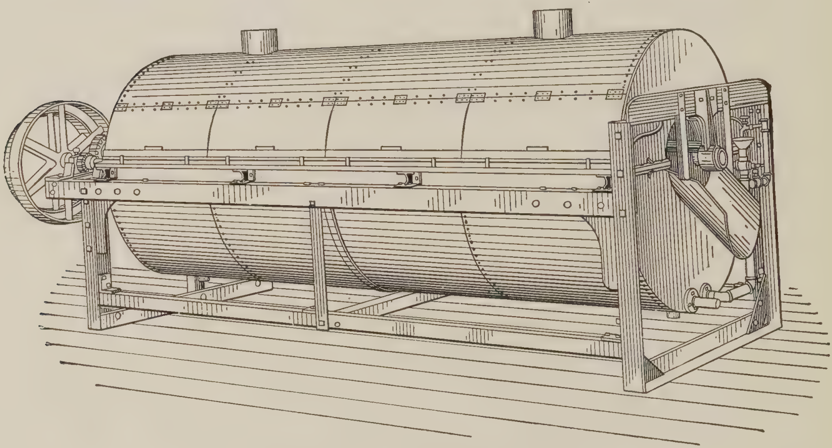

FIG. 26. Pea Blanching Machine

gives a clearer liquor than the second and third ones, which are darker, with cloudy liquor.

Finally comes the blanching of the peas before they are put in cans. See Fig. 26. The time of blanching depends greatly on the degree of maturity. It may vary from one to fifteen minutes. The harder the peas, the longer the time they have to be submitted to blanching. This proceeding not only decreases the time of processing, but also improves the appearance of the finished product. The water in which the peas are blanched should be continually renewed. After this is done they are ready to be put in cans, a step accomplished by the aid of a machine called a "Pea Filler." As this machine places a def-

inite amount of peas in the cans its work is quite satisfactory. Care should be taken to avoid bruising, which decreases the commercial value of the product.

The syrup used for filling the cans is added after they are filled with peas, and is made of salt, sugar, and water in proportions to suit the taste.

Peas are mostly packed in No. 2 cans. The old style of cans—that is to say, the soldered ones—have been supplanted by sanitary cans.

The time of processing varies from 15 to 30 minutes at 235 or 240 degrees. See Fig. 27. As has been stated before in connection with the processing of fruits, the length of time during which fruits and vegetables should be processed varies with the condition of the raw material.

The following table gives the time and temperature in the processing of peas:

TABLE No. 10

Size of Can	Grade	Processing	
		Time	Temp.
No. 2	Petit Pois	15 min.	240° F.
No. 2	Extra Sifted	16 "	240
No. 2	Sifted	25 "	240
No. 2	Early June	28 "	240
No. 2	Marrowfat	30 "	240

Tomatoes

The business of preserving tomatoes has made such vast progress, and the industry is a source of so great a part of the national wealth, that it is desirable to devote considerable space to its consideration. The following table will show the extent of the pack for the past eleven years:

Canned Tomato Pack of the United States

Year	Cases	Year	Cases
1905	6,525,000	1911	9,749,000
1906	9,950,000	1912	14,022,000
1907	13,475,000	1913	14,206,000
1908	11,479,000	1914	15,228,000
1909	10,984,000	1915	8,469,000
1910	9,235,000		

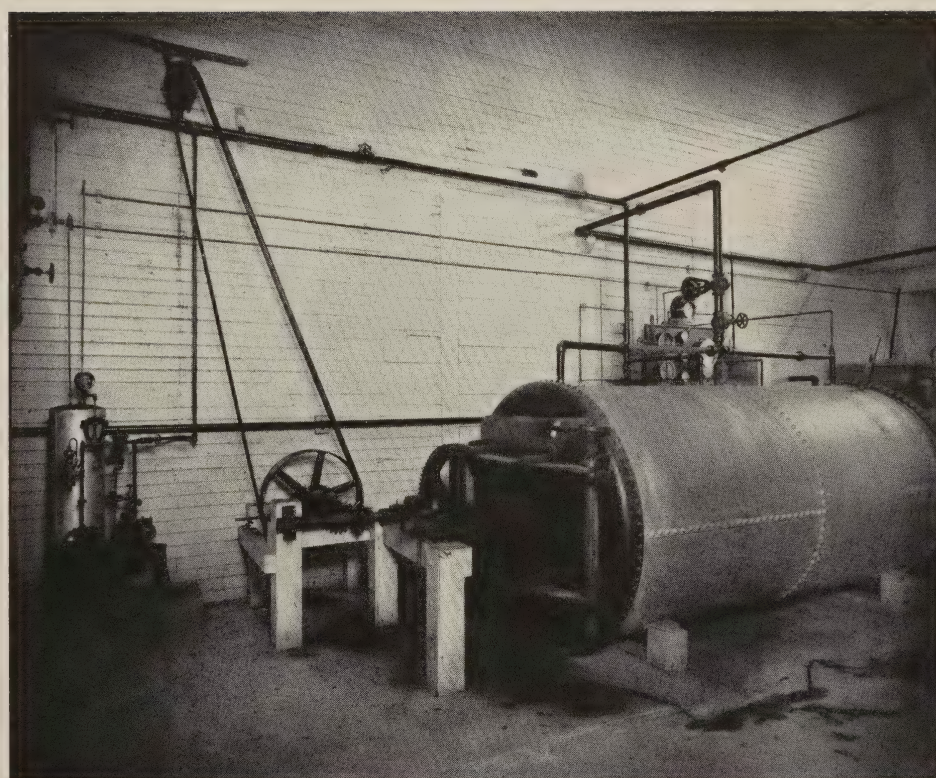

FIG. 27. Type of retort used for processing vegetables, with temperature controllers in the background.

The progress of canning, the improvement of the machinery, and also the maintenance of a high standard of raw material have steadily developed; as a result, through a persistent and intelligent evolution, the difficulties formerly found in the canning of tomatoes have been overcome to such an extent as to cut down greatly the heavy losses that occurred among the packers.

The growth of this industry, to which the progressive spirit of the Americans has contributed, becomes more evident when we consider the fact that canned tomatoes in this country are no longer a luxury, while in many South-American countries the consumption of canned goods is within the reach of the wealthier classes only.

This industry in the countries mentioned offers to people animated by a progressive spirit a splendid field for commercial action.

In particular are these wonderful opportunities to be found in the Argentine Republic, a country blessed by a genial climate and a soil of a high agricultural value, where not only the fruits of the temperate and subtropical zones, but all vegetables imaginable, may be cultivated.

At the present time the Argentine Republic cannot be considered a competitor with the United States in this industrial branch, but on account of the conditions cited we are made to realize that that country in the near future will be the chief producer in South America of canned fruits and vegetables, as it is now of cattle and cereals.

The following summary, dealing with the growing of tomatoes for canning, may be of interest to California growers:*

The ideal soil for the most profitable production of tomatoes for canning purposes is probably a sandy loam, plentifully supplied with humus, underlaid with a well-drained clay subsoil.

The best quick method of obtaining humus for tomato soils

* Bulletin No. 101, Delaware Agricultural Experiment Station.

is to precede the tomato crop with crimson clover. The experience of Delaware growers proves that, if judiciously used, a field of crimson clover turned under is an excellent place for growing tomatoes.

In the growing of tomatoes it is desirable to provide for some green clover crop to occupy the land after they are harvested. Good catches of crimson clover may be obtained by seeding at the last cultivation of the tomatoes. The roots and tops of tomatoes contain more fertilizing elements than most crops. From the standpoint of economic soil management, therefore, the tomato is good for the land.

The tomato needs a large quantity of readily available plant food during the fore part of the growing season, and a soil condition that will keep the plants well supplied with moisture, especially during the latter part of the season.

If other than sod lands precede the tomato, they should have grown legumes.

Tomatoes leave the ground in fine condition for wheat.

The tomato uses little phosphoric acid and a relatively large amount of potash.

The average amount of fertilizer used per acre in Delaware is 550 pounds of a 2–8–5 mixture.

Nitrate of soda may be used economically as a top dressing after the plants have been set in the field from two to three weeks.

The average tomato grower probably uses more phosphoric acid than the crop demands.

A commercial fertilizer that contains from 3 to 5 per cent nitrogen, that is quickly available, 5 to 7 per cent phosphoric acid, and 8 to 10 per cent potash, is recommended for tomatoes. Use 400 to 800 pounds per acre, broadcasting one-half the amount and using the remainder in the hill. Stable manure is most economically applied to the land on some other crop.

In preparing soil for tomatoes, the object should be, first, to build up a moisture reservoir that will hold quantities of moisture without free water being present, and secondly, to

prepare a seed bed that will offer the most favorable conditions for the young plants to start in.

The tomato grower should be critical as to the source of his seed. Buy only from reliable seedsmen. "Cannery run" seed should not be used. The most satisfactory course for the grower is home saving of seed. By this means the tomato crop can be steadily improved through selection. Hybrid seed of the first generation will give larger yields than either of the parents.

In crossing tomatoes, varieties of intrinsic worth should be selected always as parents.

The benefit of crossed seeds is lost in the second generation.

The crossing of tomato varieties for increased yield is a sound commercial proposition.

The seed bed should be located in a warm sandy loam soil that has been made rich by the application of well rotted manure.

Hog manure is one of the best fertilizers for seed bed.

The foundation of a tomato crop is a good, stocky, well grown plant.

Plants in the seed bed should be thinned to produce a stocky plant.

Plants that start slowly may be aided by watering with a solution of nitrate of soda, using about a thimbleful of nitrate of soda to two gallons of water.

A stockier plant may be obtained by transplanting once before setting in the field.

Spray plants in the seed bed with Bordeaux mixture once every ten days.

In setting plants in the field, the plants must be handled in a manner that does not allow them to become dry.

The seed bed should be thoroughly wet before the plants are pulled, and the young plants should never be set in dry soil.

The proper time to set tomato plants is when the atmospheric conditions are such as to cause them to transpire but little moisture. Such conditions are best obtained upon a cloudy, warm, moist day, when little wind is blowing. If the air is still

and the humidity high, it makes little difference whether the sun is shining or not.

Cultivation should begin as soon as possible after the plants are set in the field and should be kept up as long as it is possible to go through the rows without damage to either fruit or vine.

The success of a tomato crop depends largely upon the way the plants behave the first three weeks in the field.

The average cost of producing and marketing an acre of tomatoes in Delaware is $38.61.

At a contract price of $8 per ton, a grower must produce 4.8 tons of tomatoes per acre before he begins to realize any profit on the crop, and the crop cannot be called a profitable one unless at least 7 tons per acre are produced.

The cost of production is raised by the canners forcing the grower to wait hours at the cannery before he can unload.

The tenant farmer must produce a ten-ton crop of tomatoes in order to make the growing of tomatoes a profitable venture.

The grower is under obligation to deliver nothing but sound, ripe fruit to the cannery.

The Division of Horticulture has been testing tomato varieties for canning purposes for four years. Many factors have to be taken into consideration in choosing satisfactory varieties.

The average yield per acre of all varieties grown was 15.04 tons in 1909, 9.1 tons in 1910, 8.4 tons in 1911, and 15.74 tons in 1912.

Considering yield alone, the leading varieties for the past three years have been Shallcross, Favorite, Perfection, Greater Baltimore, Success, Great B. B., Magnificent, Stone, My Maryland, and Coreless.

Constancy of yield is an important factor to be considered in choosing a variety. Brandywine, Matchless, Paragon, Stone, and Hummer are leaders in this character.

The leading canning varieties in the State rank as follows in regard to average weight of individual fruits: Coreless, Delaware Beauty, Magnificent, Red Rock, Success, Matchless,

Shallcross, New Century, Greater Baltimore, Perfection, My Maryland, Paragon, Great B. B., and Hummer.

Varieties vary greatly in regard to adaptability to soil and susceptibility to disease.

A knowledge of the time consumed in ripening 50 per cent of its crop is of importance in choosing a variety. The average time is 15 days, with a minimum of 10 days for Turner Hybrid and a maximum of 19 days for Acme and Earliana. The most popular canning varieties approach the average.

Varieties may be chosen so that they present a succession of ripening periods through the canning season, thus tending to reduce periods of glut in both field and factory.

Fifty per cent ripe is a fair index by which to judge earliness or lateness.

The arrangement of varieties, according to season, as usually published by seedsmen, is apparently based on ten per cent ripe.

Stone, Paragon, Matchless, Red Rock, Success, and Delaware Beauty are the most popular varieties for canning in Delaware. Probably more acres of Stone are grown than all others combined.

There is no one best variety for all seasons and all conditions. The Delaware Station recommends Hummer, Great B. B., Greater Baltimore, Matchless, Favorite, Stone, and Brandywine, and suggests that Royal Red be given a thorough trial by the growers of the State. Where a very early pick is desired, Perfection is recommended; and where a late pick is desired, Coreless will probably prove to be the best.

Varieties of Tomatoes Mostly Used for Canning

The varieties of tomatoes mostly used for canning purposes, according to Bulletin No. 101, of the Delaware College of Agriculture Experiment Station, are the Stone, the Paragon, and the Matchless varieties.

These data were obtained through inquiries sent out to the tomato growers of Delaware.

The characteristics of the varieties mentioned are as follows:

Stone (*Red*).—Plants of Stone are large of size, vigorous of growth, healthy of foliage, and upright of habit. The roughly divided leaves are numerous and large and of a dark green color.

The fruits are above the average in size, firm and of a solid red color. Fruit clusters which bear few fruits are marked by long-stemmed hands and short persistent stems. In shape the fruits are broadly flattened and circular or elliptical of outline, varying somewhat in the latter respect. The broad and shallow cavity appears to be subject to cracking, and the blossom ends, though usually full, may sometimes be dimpled. The core sometimes large and stringy, sometimes small, is surrounded by pink flesh and yellowish red pulp, the latter giving the interior a rather pulpy appearance. The flesh is firm but fine-grained, although somewhat leathery of texture. The skin is both thick and tough. In general, the quality is good.

Stone is a fair yielder of fruits that are remarkably handsome in appearance. It ripens over a comparatively short season, and over a course of years is a rather uniform bearer. The excellent qualities of the fruit and this habit of reliable bearing are probably the best points in its favor, since the yield is excelled by several others of the same type. Stone is the leading canning tomato in Delaware.

Paragon (*Red*).—Plants of this variety are large and vigorous of growth, the branches being stout and slightly sprawling. The foliage, which is usually healthy, is made up of a few large, coarsely cut leaves of a dark green color.

The solid, red, firm fruits are borne in small clusters upon long-stemmed hands and deciduous stems. In shape the fruit is broadly flattened vertically, and is round to elliptical in cross-section. In large specimens, conspicuous ribs often occur. While the cavity is broad and shallow, the blossom end is usually smooth, but may be badly scarred or dimpled, especially in large fruits. The medium size core is apt to be heavy and hard. Light color prevails inside the thin skin, the flesh being red

with whitish tendency, and the pulp of pinkish red. The pulp and flesh are about equal in amount, the thickness of the cell wall giving the fruit its firmness. The flesh, while firm, is coarse of texture and rather insipid in flavor.

Paragon is pre-eminently a canning tomato. In yield it is medium or above; in season it has proved to be earlier than the average and it bears through a longer period than the Stone, though it is not quite so uniform in annual yield.

Matchless (*Red*).—Matchless is characterized by large, vigorous plants, slightly sprawling in habit and free from disease. Its leaves are few in number, large, of a dark green color, and marked by large and numerous divisions.

In size, the solid red fruits are large and borne in small clusters upon long hands and persistent stems. In the vertical sections the fruit is oblate, while the horizontal section is usually circular and smooth, there being few corrugations. The shallow cavity and full blossom end add further to the appearance of regularity. The fruit is commonly firm. The Matchless tomato has pinkish red flesh and yellowish red pulp, the former predominating. While the core is large, it is not tough and stringy as in some varieties. The thin tough skin encloses a flesh firm but tender and of excellent flavor.

Matchless is among the latest of the commercial varieties, though of rapid ripening habit during its season. Further, it does not appear to be thoroughly reliable as to yield from year to year. For these reasons, it is best adapted for canning where the season is long and plants are started under glass, or where it is intended to follow earlier varieties in a definite succession. Its reported dislike for sandy soils is another point to be considered in connection with it.

The operations involved in the process of canning tomatoes are very simple. They may be summarized into three general principles:

(*a*) The use of well ripened, sound, raw material.

(*b*) The observation of a very strict hygienic procedure from beginning to end.

(*c*) Great care should be used in maintaining the proper temperatures while cooking thoroughly, in order that all micro-organisms that may have accumulated during the handling of the unprocessed raw material will be destroyed.

With these purposes in view, we give a brief description of the different manipulations involved in the process of canning tomatoes.

Selection of the Raw Material

The first step is to secure good raw material, which is thoroughly washed with the aid of a shower or some other means that can give the same results. The tomatoes are then sent through the scalder, where they are submitted to the action of the hot water for a period sufficiently long enough to soften the skin, which later has to be removed. There are different types of scalders used in California canneries. When using these machines care should be taken in keeping the water as clean as possible, for in this way a better finished product can be obtained.

When the tomatoes have been scalded, they are sent to the peeling tables, where the skins are removed. There are several different types of peeling tables in use. Undoubtedly the best of all is the conveyor, which is located close to the scalder and on which the buckets filled with tomatoes travel. Empty buckets should be furnished to the help, into which they may throw the tomato skins. Through the use of the conveyor the floors can be kept clean and dry. During the peeling process care should be taken to control the work done by the women, who sometimes become careless and mix the sound, ripe tomatoes with the bad ones. If the peeling is well done, the work of the canners is greatly simplified. During the process of peeling, the green or decayed parts, which give an undesirable appearance to the product, should be removed. These parts, if left, also make the cooking more difficult. After the tomatoes are ready they are sent to the canning tables. The work done

in this section must be performed with great care and the strictest sanitary principles observed. Helpers who may have cut or injured fingers should not be allowed to handle the raw material.

The canners should classify the tomatoes in two classes:

(*a*) Those used for solid pack.

(*b*) Those used for standard pack.

These are the grades mostly packed in California canneries. The cans which are supposed to be solid pack must contain nothing but whole tomatoes with very little tomato juice. After the tomatoes are put in the cans they should be compressed in order to eliminate excess of juice, which gives an uninviting appearance to the finished product. Where the pack is standard, tomatoes of smaller size than those used in solid pack are put in the cans, which afterwards are filled with tomato juice. This tomato juice is made of overripened tomatoes which are submitted to the action of the cyclone, where they are deprived of the seeds, the juice being pumped into big tanks and cooked with a certain amount of salt. After the tomato juice is thoroughly cooked, it is ready for filling the cans.

Data in regard to sizes of cans, No. 3 and No. 2½, used for the above mentioned grades, may be found in the preceding pages of this work. The cans are filled with the required weights of tomatoes shown as follows:

Size of Cans	Grade	Weight in Oz.
No. 3	Solid pack	40 to 42½
No. 2½	Standard pack	25 to 28

After this they are sent through the exhaust box, where they receive a steam bath from seven to nine minutes in duration at a temperature which varies from 190 to 210 deg. Fahr. The temperature observed at the center and the sides of the cans during the exhausting process may be seen in the following table:

TABLE No. 11

Size of Cans	Grade of Pack	Exhausting		Temp. at the Center of Can	Temp. on the Side of Can
		Temp.	Time		
No. 3	Solid pack	210° F.	8 min.	78.8° F.	106.2° F.
No. 3	" "	210	8 "	95	149
No. 3	" "	210	8 "	98.6	143.6
No. 3	" "	210	8 "	102.2	167
No. 3	" "	210	8 "	113	147.2
No. 3	" "	210	8 "	125.6	173.3
No. 2 ½	Standard "	208	7 "	136.4	177.8
No. 2 ½	" "	208	7 "	136.4	177.8

An outfit of a successful modern cannery consists of the following equipment:

SCALDER

There are several types of scalders, and the selection is based on the ideas of the various packers, taking into consideration floor space, capacity, etc. As to the merits of the respective machines, we mention our preferences in order of rotation:

Sanitary Tomato Scalder and Washer, Fig. 28.

Improved Tomato Scalder, Fig. 29.

Hand Tomato Scalder, Fig. 30.

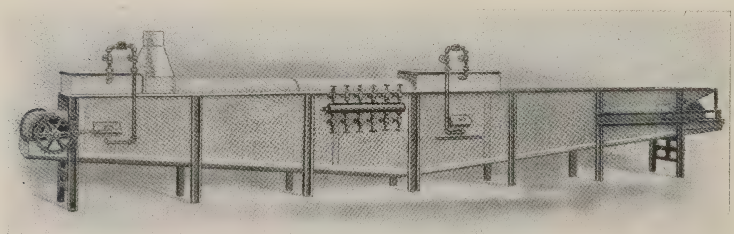

FIG. 28. Sanitary tomato scalder and washer

The tomatoes after leaving the scalders are automatically delivered onto a peeling and packing table, and one of the best designs is that shown by the Sanitary Peeling Table, Fig. 10.

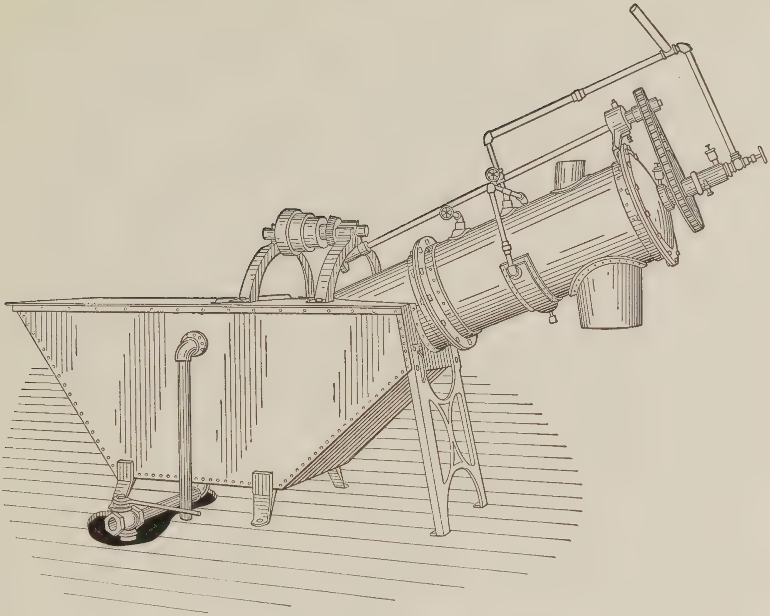

FIG. 29. Improved tomato scalder

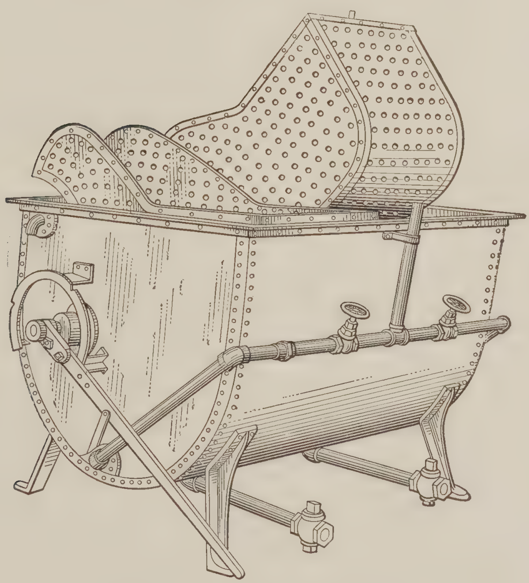

FIG. 30. Hand tomato scalder

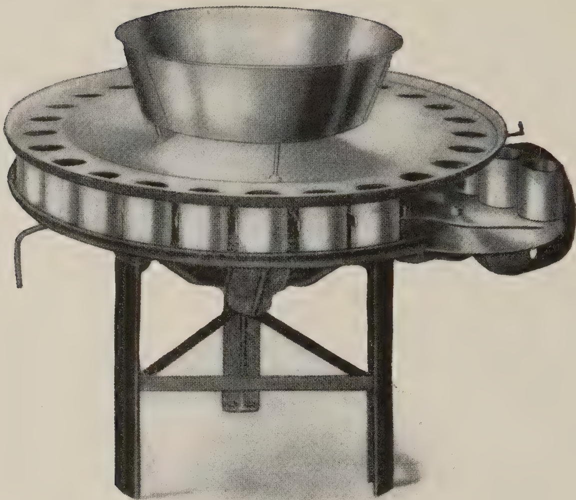

FIG. 31. Tomato filler

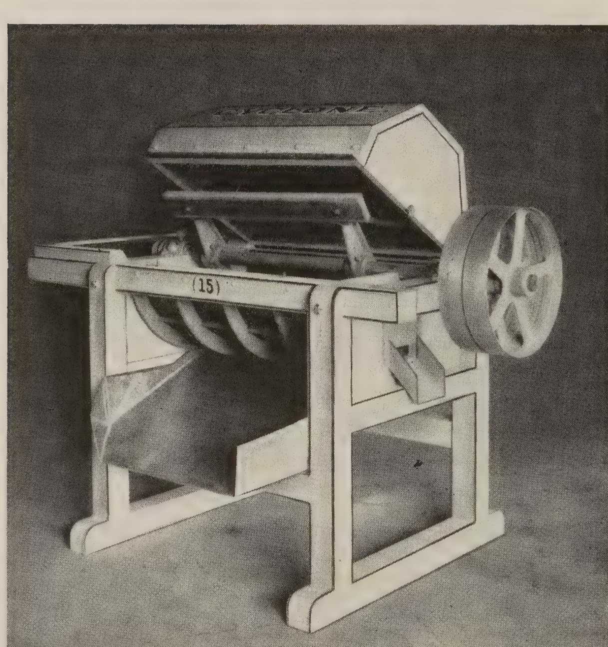

FIG. 32. Pulping machine

These tables are so constructed that as the tomatoes leave the scalder, they are carried direct before the line of basins, and if a peeler requires tomatoes, all that is necessary is to throw a switch across the lower belt and fill the basin.

As the tomatoes are peeled, they are placed in a bucket at the side of the operator, and when the bucket is filled, it is

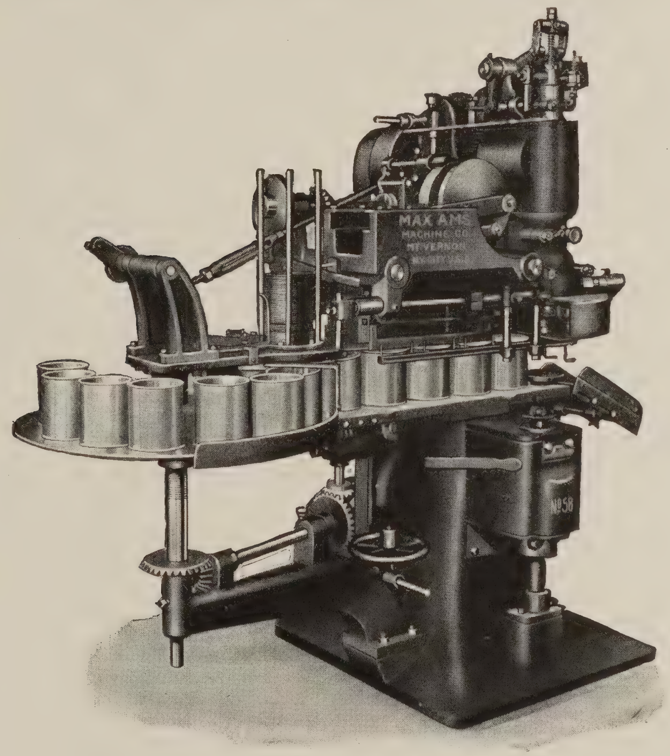

FIG. 33. Double seaming machine

placed on the top belt and carried to the tomato filler (see Fig. 31). The peelings are dropped into the hopper at the side of the operator, as shown in cut (the round hole), where they fall on a belt and are carried to the pulp machine (see Fig. 32), to be made into tomato pulp, thus utilizing all the waste.

As stated before, the peeled tomatoes are carried in the

bucket to the tomato filler, where an operator dumps the buckets into the filler.

The tomato fillers place the required amount of tomatoes in each can, and may be regulated according to the exact weight wanted.

The cans having been automatically filled, they then pass into an exhaust box (see Fig. 18), where they are given six to ten minutes' exhaust, according to the size of can.

The cans after being exhausted pass on to the double seaming machine, where the covers are placed automatically. One of the standard machines is shown in Fig. 33.

The cans, having been now entirely closed, leave the double seamer, passing to the cooking room, where they are processed as follows:

Size of Cans	Exhausting		Processing	
	Time	Temp.	Time	Temp.
No. 2½	4 min.	190° F.	35 min.	235° F.
No. 3	4 "	190	35 "	235

PART THREE

MICROORGANISMS AND SPOILAGE

METHODS FOR THE BACTERIOLOGICAL AND MICROSCOPICAL EXAMINATION OF SPOILED CANNED FOODS

The methods for the bacteriological and microscopical examination of canned foods are in a most unsatisfactory state for the reason that the work which has been done is largely based upon isolated problems and has not been systematized.

Dr. H. L. Russell,* of the University of Wisconsin, introduced bacteriological technique to American canners in the study of spoilage of peas. This was followed directly by works by Prescott and Underwood† upon the spoilage of peas and corn. In 1897 the Canadian Fish Commission began to study the cause of spoilage in lobster. A little later Harding and Nicholson‡ added to our knowledge concerning the organisms upon peas. Numerous others have made brief contributions, but the work as a whole has not yet been systematized. The structural or microscopic side of the work is even in a more chaotic state.

Our knowledge of the normal structure of most fruits, vegetables, and other foods is fragmentary and not classified so that it is available for use. Possessing neither an understanding of the normal structure of the product nor the normal flora present under different conditions we have a very poor basis upon which to make a start.

During the past four years the microscopic examination of foods has been largely based upon a method published in circular No. 68, Bureau of Chemistry. The method is an adaptation

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* Wisconsin Agr. State Report, 1895, pp. 227–231.

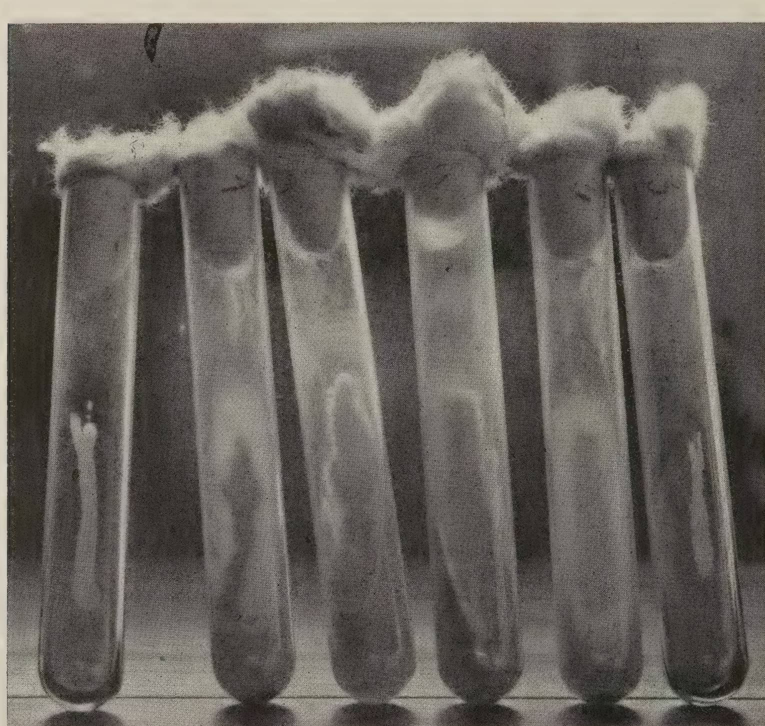
† Technological Quarterly, 1898, pp. 6–11.

‡ New York Agr. Exper. Sta., Geneva, 1903, Bul. 249.

of the microscopic examination of yeast in brewing and in blood examination.

METHODS OF MICROANALYSIS AND INTERPRETATION OF RESULTS *

The methods used for determining the character of a pulp or ketchup are given, since inquiries are repeatedly received



A	B	C	D	E	F
Yeast	Bacteria	Bacteria	Bacteria	Bacteria	Yeast

FIG. 34. Agar slants of bacteria and yeasts from swelled and leaky cans

for this information. Unfortunately they are of such a character that the manufacturer without scientific training cannot use them to any great extent, though with practice a layman

* Circular 68, Bureau of Chemistry, U. S. D. A.

might be able to judge roughly in some particulars as to the character of the product.

APPARATUS REQUIRED

The outfit used is as follows:

A good compound microscope giving magnifications of approximately 90, 180, and 500 diameters. This is accomplished by the use of a 16 mm. (two-thirds of an inch) objective and a 8 mm. (one-third of an inch) objective, together with a medium (x6 compensating) and a high-power ocular (x18 compensating). A Thoma-Zeiss blood-counting cell, a 50 cc. graduated cylinder, and ordinary slides and cover glasses complete the apparatus required. It is impracticable to use objectives of a higher power than those mentioned because of their short working distance, which makes their use with the counting cell impossible.

ESTIMATION OF MOLDS

A drop of the product to be examined is placed on a microscope slide and a cover glass is placed over it and pressed down till a film of the product about 0.1 mm. thick is obtained. After some experience this can be done fairly well. A film much thicker than this is too dense to be examined successfully, while a much thinner film necessitates pressing the liquids out, which gives a very uneven-appearing preparation. When a satisfactory mount has been obtained, it is placed under the microscope and examined. The power used is about 90 diameters, and such that the area of substance actually examined in each field of view is approximately 1.5 sq. mm.

A field is examined for the presence or absence of mold filaments, the result noted, and the slide moved so as to bring an entirely new field into view. This is repeated till approximately 50 fields have been examined, and the percentage of fields showing molds present are then calculated. Our experience has demonstrated that for home-made ketchups this is

practically zero, and with some manufactured ketchup it is as low as from 2 to 5 per cent, while for carelessly made products it may be 100 per cent; that is, every field would show the presence of mold. Investigations under factory conditions clearly indicate that with only reasonable care the proportion of fields having molds can be kept below 25 per cent. A specimen in which 60 per cent of the fields have molds is in more than twice as bad a condition as one containing 30 per cent. After the percentage reaches 30 to 40 per cent it will be found that some of the fields frequently have more than one filament or clump of mold, and the number of such fragments might be counted, but in this laboratory this usually is not done.

A Thoma-Zeiss counting cell with a center disk of 0.75 inch instead of 0.25 inch, as usually furnished, would give a regular depth of liquid and would be more exact than the method described, but this must be specially manufactured, not being listed in any of the catalogues of microscopic supplies, and the method as given is sufficiently accurate for the purpose. When the number of fragments of mold per cubic centimeter is estimated, it has been found to range virtually from zero to over 20,000. There is no excuse for a manufacturer allowing such conditions to prevail that his ketchup shows more than 2,000 per cubic centimeter, while some manufacturers, by careful handling, hold it down to 150.

ESTIMATION OF YEASTS AND SPORES

Though the spores referred to are those coming from molds and correspond to seeds in more highly developed plants, it is frequently very difficult to differentiate some of them with certainty from some yeasts without making cultures, which is obviously impossible in a product that has been sterilized by heat. For this reason the yeasts and spores have been reported together, and if there seemed to be a larger percentage of the latter, mention was made of that fact.

To make a count, 10 cc. of the product is thoroughly

mixed with 20 cc. of water, and after being allowed to rest for a moment to permit the very coarsest particles to settle out, a small drop is placed on the central disk of the Thoma-Zeiss counting cell and then covered with a glass. Care must be exercised to have the slide perfectly clean, so that, when the cover glass is put in place, a series of Newton's rings results from the perfect contact of the glass surfaces; and furthermore, the drop should be of such size as not to overrun the moat around the central disk and creep in underneath the cover glass, thus interfering with the contact. With the magnification of 180, it has been the practice in this laboratory to count the number of yeasts and spores on one-half of the ruled squares on the disk. With the dilution used this calculates back to a volume equal to one-sixtieth of a cubic millimeter in the original sample, and reports are made on that basis rather than on the number in a cubic centimeter, because the former number is more readily grasped by the mind and affords a simpler notation. To obtain the numbers per cubic centimeter, the count made is simply multiplied by 60,000.

It has been found in practice that the number of yeasts and spores varies, for one-sixtieth of a cubic millimeter, from practically none in home-made and first-class commercial ketchups up to 100 or 200, and in one sample the number was as high as 1,200. Laboratory experiments show that when the number of yeasts in raw pulp reaches from 30 to 35 in one-sixtieth of a cubic millimeter the spoilage may frequently be detectable by an expert by odor or taste; and from experiments made under proper factory conditions, it seems perfectly feasible to keep the number in commercial ketchups below 25.

ESTIMATION OF BACTERIA

The bacteria are estimated from the same mounted sample as that used for the yeasts and spores. A power of about 500, obtained by using a high-power ocular, is employed in this case, and because of the greater number present a small area

is counted over. Usually the number in several areas, each consisting of five of the small-sized squares, is counted, and the number of organisms per cubic centimeter is calculated by multiplying the average number in these areas by 2,400,000. Thus far it has proved impracticable to count the micrococci present, as they are likely to be confused with other bodies frequently present in such products, such as particles of clay, etc. A comparison of this method with the ordinary cultural methods on samples in which the organisms had not been killed has almost invariably shown that the one used gives too low instead of too high results. In some cases it was found to give not more than one-third of the entire number present. The estimates of the laboratory on this point may, therefore, be considered very conservative.

As regards the limits which may be expected in the examination of ketchups for bacteria, it might be stated that some manufactured samples, as well as good, clean products made by household methods, have been examined and the count found to be so low when estimated by this method that the numbers present were reported as negligible. In other words, it was found that for areas counted over, the number of bacteria averaged less than one—that is, less than 2,400,000 per cubic centimeter. It is unusual, however, for the final number per cubic centimeter to be less than from 2,000,000 to 10,000,000 organisms. Contrasted with this number as a minimum, it has been found that the number has occasionally exceeded 300,000,000 per cubic centimeter. Such a number as this would indicate extremely bad conditions and carelessness in handling, as the studies of factory conditions have shown that there is little excuse for the number ever exceeding 25,000,000 per cubic centimeter. While experiments have also shown that although the effect produced by the bacteria on the product varies with different species, it is true that their presence can frequently be detected in the raw pulp by odor or taste when the number exceeds 25,000,000 per cubic centimeter, and sometimes when the count is as low as 10,000,000.

To one who has not been initiated into the mysteries of the microscope the presence of such a number of bacteria in a food product seems inexcusable. It must be remembered in this connection that the most of these are probably nonpathogenic forms, and many occur naturally on the skins of the fruits. It does not seem just to set a standard so high as virtually to prohibit the manufacture of the product under commercial conditions; rather the idea is to set a limit that the manufacturer can attain if due care is exercised and which will insure a cleanly product. It is, however, perfectly possible to make a cleanly, wholesome product commercially even though the number of bacteria exceed that in the home-made article.

The allowable limits for the bacterial content of tomato pulp vary according to the concentration. The number, however, should be low enough so that when the amount of concentrating necessary for its conversion into ketchup has been accomplished the final product will still be within permissible limits (25,000,000 per cubic centimeter). Thus for a pulp which must be concentrated one-half the bacterial counts should not exceed about half the limit stated above for the ketchup itself—*i.e.*, it should not be more than 12,500,000 per cubic centimeter. The same general rule should also apply to the content of molds and of yeasts.

To insure a sound product, free from decay or any filthy material, many factors must be carefully watched, for not infrequently oversight in one particular has been found to have undone the good effects of the care exercised in all other ways. Thus it is possible for the washing of the fruit to be ideal and the sorting out or removing of the decayed portions beyond criticism, and yet a delay in making up the pulp into the final product may allow an amount of decomposition to occur which offsets the care previously exercised. It was a matter of surprise to some manufacturers to find with what rapidity some of these organisms increase. In one factory where this point was tested the bacterial content in a batch of tomato-trimming juice was found to be about 7,000,000 per cubic centimeter when taken

from the peeling tables, and after standing at room temperature for five hours it had increased to 84,000,000. This was a twelve-fold increase in a length of time which was less than half the working day for some of the factories visited. At the end of five days the number had increased to nearly 3,000,000,000 per cubic centimeter. Thus it is seen that delay in manufacture is very liable to result disastrously.

In view of the above we deem it of importance to quote part of the investigation made on the same subject by Dr. A. W. Bitting and Mrs. K. G. Bitting.*

The equipment given in Circular No. 68 is adequate for working upon blood or yeast, but is wholly inadequate for bacteriological work, except that of the simplest character and under conditions quite different from those found in ketchup and other food products.

The counting apparatus or chamber recommended is known as the Thoma-Zeiss haemacytometer, named from the designer and maker. The apparatus consists of a heavy glass slip, on which is cemented a glass 0.2 mm. thick, having a circular hole in the middle. In the center of the hole is mounted a smaller disk 0.1 mm. thick, leaving an annular space. In the middle of the small inner disk are etched two sets of twenty-one parallel lines which cut each other at right angles. The drop of liquid to be examined is placed on this square, after which it is covered with a specially heavy cover-glass, which, if perfect and adjusted so closely that Newton's rings appear, gives a layer of liquid 0.1 mm. in depth. The drop to be examined must be so small that it remains in the middle of the chamber, but in contact with the cover-glass and the bottom of the cell. Each of the ruled squares is 0.1 mm., and as there are 20 spaces on a side, there is a total of 400 small squares, the depth being 0.1 mm., thus the cubical content of each is 1–4,000 cm. or 1–4,000,000 cc. For convenience in counting, every fifth space is subdivided. Other counting chambers have been devised based on

* Ketchup, Methods of Manufacture and Microscopic Examination. Lafayette, Ind., 1915.

the same principle, but varying chiefly in their rulings for convenience in counting. The other apparatus recommended consists of a 50 cc. graduated cylinder, slides, and cover-glasses.

Since the counting chamber has been extensively used in blood examination and in yeast work, a brief description of the technique as followed in the latter may serve to give a better understanding of its limitations. First, in the preparation of the sample, the cylinder and flasks for mixing and the pipette must be absolutely clean. The liquid to be examined is thoroughly shaken and then the measured sample withdrawn as quickly as possible, to prevent the cells from settling, and diluted with weak sulphuric acid (about 10 per cent), which prevents any further development of cells, and also aids both in the separation of the cells from one another and in their suspension—the latter factor being important only when a single drop is taken for examination.

In using the counting chamber for counting yeast cells and blood corpuscles, for which it was originally devised, the bodies to be examined are fairly large, well defined, and suspended in a fairly clear liquid, usually of rather high specific gravity. Even with these favorable conditions, the work must be done by observing the most careful technique in order to get relative results which will be of value, and they are absolutely useless if any detail has been slighted or neglected. In attempting to adapt the method to food products, very different conditions are encountered—conditions which are opposed to obtaining accurate results. Food products, like ketchup, consist of a mixture of solids and liquids in which are various forms of organisms, the latter in varying condition, due to their environment and treatment, as well as to stages of disorganization.

In estimating the number of yeasts and spores in pulp or ketchup, the Thoma-Zeiss counting chamber is used and the mount observed under a magnification of 180 diameters. To prepare the sample, 10 cc. of the material has 20 cc. of water added and is "thoroughly mixed." Before taking a drop for examination, the sample is allowed to rest for a "moment" to

allow the "coarsest particles" to settle. This step in the technique is not as clear as could be desired, for what might be considered as "thoroughly mixed" by one microscopist in a half dozen shakings of the cylinder might not be so construed by another even with sixty shakings. As the material consists of both solids and liquid, this is a very important detail, as it may easily account for some of the wide differences in results obtained by different workers on the same sample. In a bulletin* dealing with the examination of solid foods, the following statement occurs relative to the shaking in order to be able to obtain the bacterial condition: "The longer the shaking, the more perfect was the diffusion of particles. It could not, however, be continued beyond a comparatively short period of time, because of the multiplication of organisms. With the quantities of tissue above stated, ten minutes' shaking was selected as a happy medium between an undesirable multiplication of the organisms on the one hand and the retention of the organisms by the tissue and the consequent lowering of the numbers found, on the other." The organisms in pulp or ketchup are dead, or, if alive, do not possess such phenomenal power of multiplication; therefore the shaking should be conducted with sufficient energy and for a sufficient time to insure their separation from the tissue. Furthermore, "letting stand for a moment" may mean thirty seconds or two or three minutes to different persons.

In all biological work involving the counting of organisms, either by the plate or direct method, in the case of yeast, the operator works as rapidly as possible to prevent the organisms from settling, so as to have them evenly distributed, in order that he may obtain an average sample. A pipette is used for removal of a drop of the liquid and the drop placed in the chamber as quickly as possible to prevent settling. No directions are given as to how the drop of the diluted pulp or ketchup is to be removed to the chamber, so that a stirring rod or other apparatus is frequently used, as the solid particles interfere with

* No. 115, Bureau of Chemistry, Dept. of Agr.

the use of a fine pipette. If the rod be inserted to the bottom, or nearly to the bottom, of the mixture and withdrawn slowly and another withdrawn somewhat rapidly, a difference of fifty per cent or even more may result in the count. It is not possible for different operators to use pipettes, glass rods, penknives, toothpicks, and matches for drawing the samples, and get comparable results. (All of these have been seen in use.) It has been found that in the counting of the organisms in pulp and ketchup, some persons use distilled water, others tap water, some clean their measuring flasks and pipettes, while others rinse them, so that naturally reports are made of such varying numbers that manufacturers do not look upon the method with confidence. It is only by using uniform methods and exercising the same care necessary for other biological work that even an approximation can be made.

THE COUNTING OF YEASTS AND SPORES

To obtain the number of yeasts and spores in the sample, a count is made in one-half of the ruled squares. Two hundred squares represent a volume equivalent to 1–20 c.mm., which, multiplied by the dilution, would give the number in 1–60 c.mm. The belief is stated that it is possible for manufacturers to keep the count below 25 per 1–60 c.mm.

ESTIMATION OF BACTERIA

The same mount is used in estimating the bacteria, but the x18 ocular is used so as to increase the magnification to approximately 500 diameters. The "number in several areas, each consisting of five of the small squares, is counted." Nothing is said as to the order of the five squares, whether in a row or other arrangement, nor what number constitutes "several." The average number found in five squares represents the number in 1–800,000 part of a c.c., and this multiplied by 3, for the dilution, would make the factor 1–2,400,000 for a c.c. Credence is accorded the statement that it is possible for manufacturers

to keep within 12,500,000 bacteria per c.c. in the pulp and 25,000,000 in ketchup. The number present is expressed in terms per c.c. though the yeast and spores are expressed in 1–60 c.mm. Possibly to the lay mind bacteria means something dangerous, so by expressing the numbers in millions they appear appalling. Yeasts and spores are not so generally associated with dirt and disease, so that by giving them a small unit, only 1–60,000 part of a c.c., they may seem much less offensive. If the mind is capable of conceiving what is meant by millions per c.c. for bacteria in one case, there seems to be no good reason why the same unit of volume should not hold for the other.

To estimate the number of molds present, a drop of the undiluted pulp or ketchup is placed on an ordinary slide and the ordinary cover-glass pressed down until a film of 0.1 mm. is obtained. The directions state that after some experience this can be done, but they fail to state how one's efforts may be directed to obtain this result. It is apparent that by experience in comparing a measured amount with a judged amount, the tendency would be toward accuracy, but in this case there is no measured amount for comparison, except the diluted drop in the counting chamber. Some workers have placed thin cover-glasses under the edges of the mount so as to provide something to help in estimating the thickness of the film, but as the thinnest ordinary cover-glasses vary from 0.12 to 0.17 mm. in thickness, the error varies 20 to 70 per cent from that required. One manufacturer, in advertising No. 1 cover-glasses, states that they vary from 0.13 to 0.17 mm., while another states they vary from 1–200 to 1–150 of an inch (0.127 to 0.169 mm.). Careful checks show that it is not always easy to get exactly 0.1 mm. on the specially prepared counting chamber, that unless the cover be placed with care and pressed uniformly on all sides until Newton's rings appear, a variation of ten per cent or more in thickness may occur, and without such a guide the error becomes greater. The micrometer screw adjustment on the microscope can be used to help in deter-

mining the thickness, but none of the workers observed has used this refinement.

ESTIMATION OF MOLDS

The examination for mold is made with the x6 ocular and 16 mm. objective, giving a magnification of approximately 90 times. About 50 fields are supposed to be examined, and the result expressed in terms of the per cent in which mold was found. The belief is acknowledged that manufacturers can so conduct their operations that mold will not be present in more than 25 per cent on the fields. There are, therefore, three units in which to express the results: bacteria, in cubic centimeters; yeasts and spores, in one-sixtieth of a cubic millimeter; and molds, in percentage of microscopic fields.

In counting molds, no distinction is made as to whether a small bit is in the field or a large mass. In making a mount for molds, the solids generally tend to stay in the center of the field while the liquid tends to run to the edge. The fields selected may therefore give a high or low result, determined by their location. One examiner, desiring to favor the manufacturer, may select the outer part for most of the fields, while another, making the examination for the buyer, who may wish to make a rejection, may reverse the operation. Some persons modify the directions given by counting only pieces which are one-sixth the diameter of the field, while others use a smaller fraction. It is easily possible to have one clump of mold in one field which will be twenty to thirty times in extent that of another, yet both are given equal value in the final expression.

COLLECTING SAMPLES FROM SPOILED CANNED FOODS

The bacteriological methods for the examination of food products are in the main the same as those used in general bacteriological work, and are too complex to be considered in a work of this character.

The very important difference is that the media used should be derived in part from the same product as that under investigation: that is, if tomatoes are under investigation, tomato bouillon and gelatine should be used. Furthermore, the acidity should be maintained near that of the product from which the organisms are taken. Another very important item is that the test be made at high temperature as well as the ordinary.

There are some organisms that require a temperature of 135 deg. Fahr. to develop, and if only the usual methods be followed an error may be made in determining sterility.

The very important factor for the canner is to be able to test his pack. This is possible, to a very large extent, by placing cans from each day's run in a warm closet or an incubator. The incubators should be held at 100 deg. Fahr. and the cans left in for two weeks. If they are not sterile, the contents will either swell or sour. On peas, corn, and beans, a temperature of 135 deg. Fahr. is especially desirable, in order to determine the presence of flat sours. The usual incubator is too small to hold many cans, and in large factories it is desirable to build a special room and keep it warm. For small factories, a refrigerator may be used, and a heating device made to take the place of ice. This heat test for sterility will be about all that is needed by the packer. The development of swells or sours will show so much earlier in the incubator than in the stack, so that it would be possible to reprocess before any damage can occur to the pack.

Direct examinations, under the microscope, of samples taken from spoiled canned goods (apricots, peaches, pears, asparagus, peas, tomatoes, etc.) have shown that the microorganisms present vary with the nature of the decomposition which has occurred.

On examining samples from "swelled" cans, it was found that the organisms present were bacteria only. In some cases, it was possible to isolate more than one kind of bacteria, while in others only one seemed to predominate. In the case of strictly "swelled" cans, the presence of yeasts and molds must be dis-

carded for the reason that their thermal death-point is very low compared with that of bacteria. In the case of swelled cans, due to "leaks," the flora that can be found is formed of yeasts, molds, and bacteria. This is explained by the fact that these microorganisms gain their entrance through small openings which in some cases cannot be detected. For this reason, lack of sterilization should not be held responsible for alterations in canned goods

In all, 285 samples were examined from six canneries; 250 cans were opened, examined, and plated, and 685 cultures made.

FIG. 35. Normal can Swelled can Burst can

The cans were sterilized by washing thoroughly with sand soap and water, and then covering with 95 per cent alcohol and burning the alcohol. They were opened with an awl sterilized in the Bunsen flame. The cultures made were examined carefully, and the most prevalent types taken for detailed description, which is given in the following pages. The methods described in "Klöcker's Fermentation Organisms" and Lafar's "Technical Mycology" were taken for description of yeasts and molds.

DESCRIPTION OF THE DIFFERENT ORGANISMS THAT WERE FOUND GROWING IN SWELLED CANS

Organism A

This organism was found growing in swelled cans of tomatoes and peas.

FIG. 36. Microorganism A was found growing in swelled cans of tomatoes and peas

I. Morphology:
  1. Vegetative cells.
    (*a*) Form short rods.
    (*b*) Limits of size, 2 × 62 microns.
    (*c*) Size of the majority, 2.9 × 72 microns.
    (*d*) Ends rounded.
  2. Endospores:
    (*a*) Position Polar.
    (*b*) Form round.
    (*c*) Size .62 micron.
  3. Flagella:
    (*a*) Positive.

4. Staining:
    (*a*) Gram Positive.

II. Cultural Features:

1. Agar stroke:
    (*a*) Growth—Abundant.
    (*b*) Form—Spreading.
    (*c*) Elevation—Flat.
    (*d*) Luster—Glistening.
    (*e*) Topography—Smooth.
    (*f*) Odor—Absent.
    (*g*) Consistency—Membranose.
2. Gelatine Stab:
    (*a*) Growth—Best at top.
    (*b*) Line of Puncture—Filiform.
    (*c*) Liquefaction—Stratiform.
3. Nutrient Broth.
    (*a*) Surface growth—Pellicle.
    (*b*) Clouding—None.
    (*c*) Odor—Absent.
    (*d*) Sediment—Viscid on Agitation.
4. Litmus Milk:
    (*a*) Alkaline.
    (*b*) Prompt reduction.
5. Gelatine Colonies:
    (*a*) Growth—Rapid.
    (*b*) Form—Irregular.
    (*c*) Elevation—Liquefying.
    (*d*) Liquefaction—Spreading.
6. Agar Colonies:
    (*a*) Growth—Rapid—Temperature 87.6° F.
    (*b*) Form—Irregular.
    (*c*) Surface—Smooth.
    (*d*) Elevation—Flat.
    (*e*) Edge—Lacerate.
    (*f*) Internal Structure—Finely Granular.

III. Physical and Biochemical Features:

1. Fermentation tubes contain peptone, water and
   - (*a*) Dextrose: Gas—Negative. Reaction—Neutral.
   - (*b*) Saccharose: Gas—Negative. Reaction—Slightly Acid.
   - (*c*) Lactose: Gas—Negative. Reaction—Neutral.

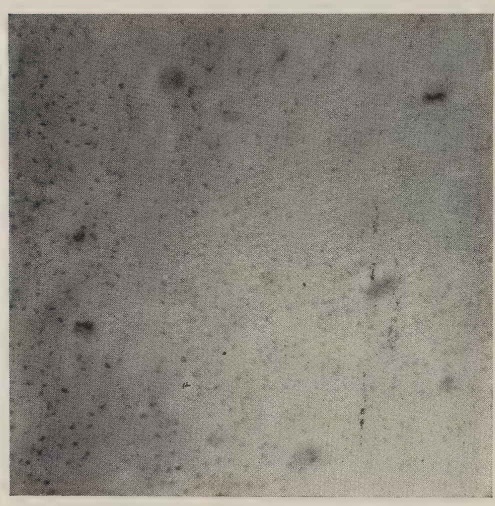


FIG. 37. Photomicrograph of Organism A. These bacteria—short rods—were found growing in swelled cans of tomatoes and peas

2. Indol Formation:
   - (*a*) Negative.
3. Temperature Relations:
   - (*a*) Not killed at 212 deg. Fahr. for five minutes.
   - (*b*) Killed at 212 deg. Fahr. for eighteen minutes.
   - (*c*) Killed at 225 deg. Fahr. for three minutes.

Organism B

This organism was found growing in swelled cans of pears.

I. Morphology:

1. Vegetative Cells.
   (a) Form—Long Rods.
   (b) Limits of Size—4.06 × 78 microns.
   (c) Size of the majority—3.77 × .72 microns.
   (d) Ends—Rounded.

FIG. 38. Microorganism B was found growing in swelled cans of pears

2. Endospores:
   (a) Position—Polar.
   (b) Form—Elongated.
   (c) Sizes—.58 × .62 microns.
3. Flagella:
   (a) Positive.
4. Staining.
   (a) Gram—Negative.

II. Cultural Features:

1. Agar Stroke.
   (a) Growth—Abundant.

(*b*) Form—Spreading.
(*c*) Elevation—Flat.
(*d*) Luster—Glistening.
(*e*) Topography—Smooth.
(*f*) Odor—Absent.
(*g*) Consistency—Slimy.

2. Gelatine Stab:
(*a*) Growth—Best at top.
(*b*) Line of Puncture—Filiform.
(*c*) Liquefaction—Crateriform.

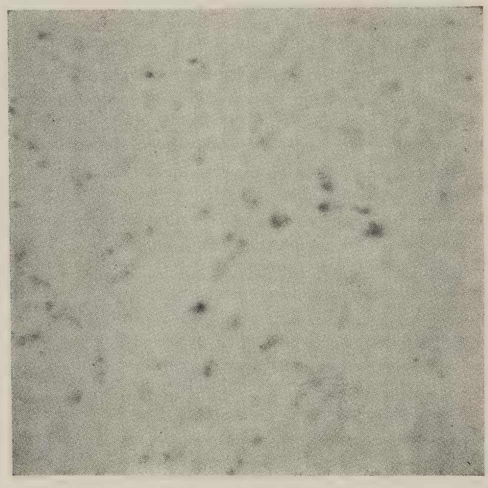


FIG. 39. Photomicrograph of Organism B. These bacteria—long rods—were found growing in swelled cans of pears

3. Nutrient Broth:
(*a*) Surface Growth—None.
(*b*) Clouding—Slight.
(*c*) Odor—Absent.
(*d*) Sediment—Scant.

4. Litmus Milk:
(*a*) Alkaline.
(*b*) Prompt Reduction.

5. Gelatine Colonies:
   (*a*) Growth—Slow.
   (*b*) Form—Irregular.
   (*c*) Elevation—Liquefying.
   (*d*) Liquefaction—Spreading.
6. Agar Colonies:
   (*a*) Growth—Slow—Temperature 75.6° F.
   (*b*) Form—Irregular.
   (*c*) Surface—Smooth.
   (*d*) Elevation—Convex.
   (*e*) Edge—Undulate.
   (*f*) Internal Structure—Finely Granular.

III. Physical and Biochemical Features:
1. Fermentation tubes containing peptone, water, and
   (*a*) Dextrose: Gas—Negative. Reaction—Neutral.
   (*b*) Saccharose: Gas—Negative. Reaction—Neutral.
   (*c*) Lactose: Gas—Negative. Reaction—Neutral.
2. Indol Formation:
   (*a*) Negative.
3. Temperature Relations:
   (*a*) Not killed at 212 deg. Fahr. for five minutes.
   (*b*) Killed at 212 deg. Fahr. for ten minutes.
   (*c*) Killed at 225 deg. Fahr. for three minutes.

Organism C

This organism was found growing in swelled cans of peaches and pears.

I. Morphology:
1. Vegetative Cells:
   (*a*) Form—Short rods.
   (*b*) Limits of size—1.5 × .58 microns.
   (*c*) Size of the majority—1.45 × .96 microns.
   (*d*) Ends—Rounded.

2. Endospores.
   (*a*) Position—Polar.
   (*b*) Form—Round.
   (*c*) Size—.58 microns.

3. Flagella:
   (*a*) Positive.

4. Staining:
   (*a*) Gram—Positive.

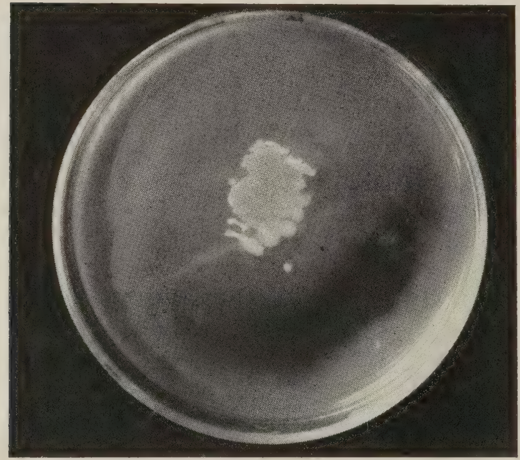


FIG. 40. Microorganism C was found growing in swelled cans of peaches and pears

II. Cultural Features:

1. Agar Stroke:
   (*a*) Growth—Abundant.
   (*b*) Form—Spreading.
   (*c*) Elevation—Flat.
   (*d*) Luster—Glistening.
   (*e*) Topography—Smooth.
   (*f*) Odor—Absent.
   (*g*) Consistency—Viscid.

2. Gelatine Stab:
   (*a*) Growth—Best at top.
   (*b*) Line of Puncture—Arborescent.
   (*c*) Liquefaction—Crateriform.

3. Nutrient Broth:
   (*a*) Surface Growth—Pellicle.
   (*b*) Clouding—Strong.
   (*c*) Odor—Absent.
   (*d*) Sediment—Abundant.

4. Litmus Milk:
   (*a*) Alkaline.
   (*b*) Prompt Reduction.

5. Gelatine Colonies.
   (*a*) Growth—Rapid.
   (*b*) Form—Irregular.
   (*c*) Elevation—Flat.
   (*d*) Liquefaction—Spreading.

6. Agar Colonies:
   (*a*) Growth—Rapid—Temperature 72.4° F.
   (*b*) Form—Rhizoid.
   (*c*) Surface—Smooth.
   (*d*) Elevation—Flat.
   (*e*) Edge—Lacerate.
   (*f*) Internal Structure—Coarsely Granular.

III. Physical and Biochemical Features:

1. Fermentation tubes contain peptone, water, and
   (*a*) Dextrose: $\left\{\begin{array}{l}\text{Gas—Negative.}\\ \text{Reaction—Slightly Acid.}\end{array}\right.$
   (*b*) Saccharose: $\left\{\begin{array}{l}\text{Gas—Negative.}\\ \text{Reaction—Neutral.}\end{array}\right.$
   (*c*) Lactose: $\left\{\begin{array}{l}\text{Gas—Negative.}\\ \text{Reaction—Neutral.}\end{array}\right.$

2. Indol Formation:
   (*a*) Positive.

3. Temperature Relations:
   (*a*) Not killed at 212 deg. Fahr. for five minutes.
   (*b*) Killed at 212 deg. Fahr. for eighteen minutes.
   (*c*) Killed at 225 deg. Fahr. for three minutes.

Organism D

This organism was found growing in swelled cans of pears, peaches, and apricots.

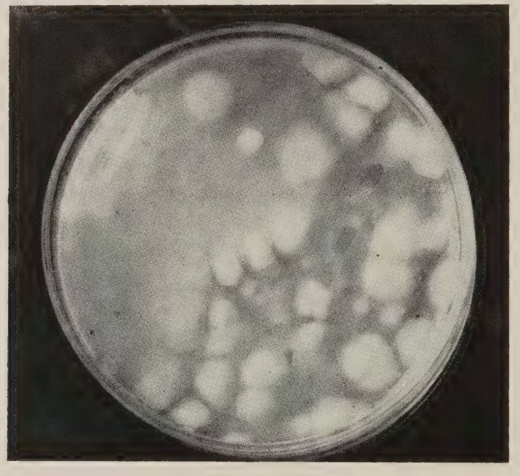


FIG. 41. Microorganism D was found growing in swelled cans of pears, peaches, and apricots

I. Morphology:
1. Vegetable Cells:
   (*a*) Form—Short Rods.
   (*b*) Limits of size—1.4 × .72 microns.
   (*c*) Size of the majority—2.9 × .98 microns.
   (*d*) Ends—Rounded.
2. Endospores:
   (*a*) Position—Bi-Polar.
   (*b*) Form—Round.
   (*c*) Size—.64 micron.

3. Flagella:
   (*a*) Positive.
4. Staining:
   (*a*) Gram—Negative.

II. Cultural Features:
1. Agar Stroke:
   (*a*) Growth—Abundant.
   (*b*) Form—Spreading.
   (*c*) Elevation—Flat.
   (*d*) Luster—Glistening.
   (*e*) Topography—Smooth.
   (*f*) Odor—Absent.
   (*g*) Consistency—Slimy.
2. Gelatine Stab:
   (*a*) Growth—Best at top.
   (*b*) Line of Puncture—Filiform.
   (*c*) Liquefaction—Crateriform.
3. Nutrient Broth:
   (*a*) Surface Growth—Pellicle.
   (*b*) Clouding—Slight.
   (*c*) Odor—Absent.
   (*d*) Sediment—Abundant.
4. Litmus Milk:
   (*a*) Alkaline.
   (*b*) Slow Reduction.
5. Gelatine Colonies:
   (*a*) Growth—Rapid.
   (*b*) Form—Irregular.
   (*c*) Elevation—Flat.
6. Agar Colonies:
   (*a*) Growth—Rapid—Temperature 87.6° F.
   (*b*) Form—Irregular.
   (*c*) Surface—Smooth.
   (*d*) Elevation—Flat.
   (*e*) Edge—Lacerate.
   (*f*) Internal Structure—Coarsely Granular.

III. Physical and Biochemical Features:

1. Fermentation tubes contain peptone, water and
    - (a) Dextrose: { Gas—Negative. Reaction—Slightly Acid.
    - (b) Saccharose: { Gas—Negative. Reaction—Slightly Acid.
    - (c) Lactose: { Gas—Negative. Reaction—Neutral.
2. Indol Formation:
    - (a) Positive.
3. Temperature Relations:
    - (a) Not killed at 212 deg. Fahr. for five minutes.
    - (b) Killed at 212 deg. Fahr. for eighteen minutes.
    - (c) Killed at 225 deg. Fahr. for three minutes.

Organism E

This organism was found growing in swelled cans of pears.

I. Morphology:

1. Vegetative Cells:
    - (a) Form—Long Rods.
    - (b) Limits of size—4.35 × .72 microns.
    - (c) Size of the majority—4.23 × 59 microns.
    - (d) Ends—Rounded.
2. Endospores:
    - (a) Position—Bi-Polar.
    - (b) Form—Elongated.
    - (c) Size —.92 × 68 microns.
3. Flagella:
    - (a) Positive.
4. Staining:
    - (a) Gram—Positive.

II. Cultural Features:

1. Agar Stroke:
    - (a) Growth—Abundant.
    - (b) Form—Spreading.

(*c*) Elevation—Flat.
(*d*) Luster—Glistening.
(*e*) Topography—Smooth.
(*f*) Odor—Absent.
(*g*) Consistency—Slimy.

2. Gelatine Stab:
   (*a*) Growth—Best at top.
   (*b*) Line of Puncture—Filiform.
   (*c*) Liquefaction—Stratiform.

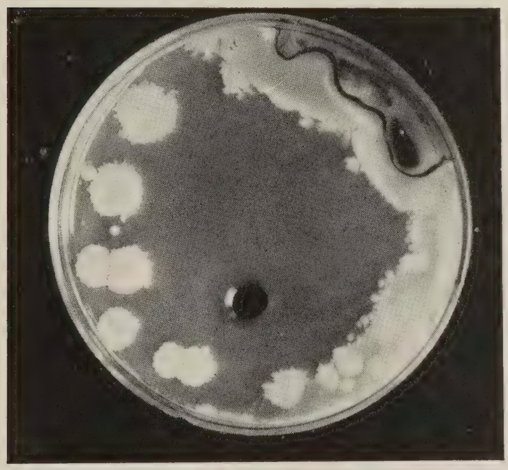


FIG. 42. Microorganism E was found growing in swelled cans of pears

3. Nutrient Broth:
   (*a*) Surface Growth—Pellicle.
   (*b*) Clouding—Abundant.
   (*c*) Odor—Absent.
   (*d*) Sediment—Abundant.
4. Litmus Milk:
   (*a*) Alkaline.
   (*b*) Prompt Reduction.
5. Gelatine Colonies:
   (*a*) Growth—Slow.

(*b*) Form—Irregular.
(*c*) Elevation—Liquefying.
(*d*) Liquefaction—Spreading.

6. Agar Colonies:
(*a*) Growth—Rapid—Temperature 82.4° F.
(*b*) Form—Irregular.
(*c*) Surface—Smooth.
(*d*) Elevation—Flat.
(*e*) Edge—Lacerate.
(*f*) Internal Structure—Coarsely Granular.

III. Physical and Biochemical Features:

1. Fermentation tubes contain peptone, water, and
(*a*) Dextrose: { Gas—Negative. Reaction—Neutral.
(*b*) Saccharose: { Gas—Negative. Reaction—Neutral.
(*c*) Lactose: { Gas—Negative. Reaction—Neutral.

2. Indol Formation:
(*a*) Negative.

3. Temperature Relations:
(*a*) Not killed at 212 deg. Fahr. for five minutes.
(*b*) Killed at 212 deg. Fahr. for eighteen minutes.
(*c*) Killed at 225 deg. Fahr. for three minutes.

Organism F

This organism was found growing in swelled cans of tomatoes.

I. Morphology:

1. Vegetative Cells:
(*a*) Form—Short Rods.
(*b*) Limits of size—2.9 × .58 microns.
(*c*) Size of the majority—2.6 × .59 microns.
(*d*) Ends—Rounded.

2. Endospores:
(*a*) Position—Bi-Polar.

(*b*) Form—Round.
(*c*) Size—.58 microns.

3. Flagella:
   (*a*) Positive.
4. Staining:
   (*a*) Gram—Positive.

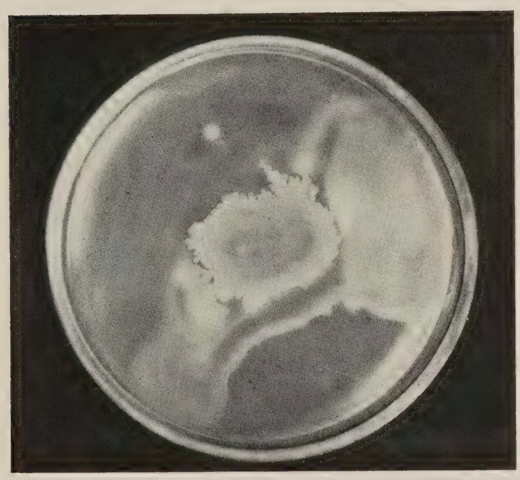


FIG. 43. Microorganism F was found growing in swelled cans of tomatoes

II. Cultural Features:

1. Agar Stroke:
   (*a*) Growth—Abundant.
   (*b*) Form—Spreading.
   (*c*) Elevation—Flat.
   (*d*) Luster—Glistening.
   (*e*) Topography—Smooth.
   (*f*) Odor—Absent.
   (*g*) Consistency—Slimy.
2. Gelatine Stab:
   (*a*) Growth—Best at top.
   (*b*) Line of Puncture—Filiform.
   (*c*) Liquefaction—Stratiform.

3. Nutrient:
   (*a*) Surface Growth—Pellicle.
   (*b*) Clouding—None.
   (*c*) Odor—Absent.
   (*d*) Sediment—Compact.
4. Litmus Milk:
   (*a*) Alkaline.
   (*b*) Prompt Reduction.
5. Gelatine Colonies:
   (*a*) Growth—Rapid.
   (*b*) Form—Irregular.
   (*c*) Elevation—Effuse.
   (*d*) Liquefaction—Spreading.
6. Agar Colonies:
   (*a*) Growth—Rapid—Temperature 87.6° F.
   (*b*) Form—Irregular.
   (*c*) Surface—Smooth.
   (*d*) Elevation—Flat.
   (*e*) Edge—Moruloid.
   (*f*) Internal Structure—Finely Granular.

III. Physical and Biochemical Features:

1. Fermentation tubes containing peptone, water, and
   (*a*) Dextrose: $\begin{cases}\text{Gas—Negative.}\\ \text{Reaction—Neutral.}\end{cases}$
   (*b*) Saccharose: $\begin{cases}\text{Gas—Negative.}\\ \text{Reaction—Neutral.}\end{cases}$
   (*c*) Lactose: $\begin{cases}\text{Gas—Negative.}\\ \text{Reaction—Neutral.}\end{cases}$
2. Indol Formation:
   (*a*) Positive.
3. Temperature Relations:
   (*a*) Not killed at 212 deg. Fahr. for five minutes.
   (*b*) Killed at 212 deg. Fahr. for twenty-five minutes.
   (*c*) Killed at 225 deg. Fahr. for three minutes.

Organism G

This organism was found growing in swelled cans of peaches.

I. Morphology:
  1. Vegetative Cells:
    (*a*) Form—Short Rods.
    (*b*) Limits of size—$2.6 \times .67$ microns.
    (*c*) Size of the majority—$2.8 \times .73$ microns.
  2. Endospores:
    (*a*) Position—Polar.
    (*b*) Form—Round.
    (*c*) Size—.74 microns.
  3. Flagella:
    (*a*) Positive.
  4. Staining:
    (*a*) Gram—Positive.

II. Cultural Features:
  1. Agar Stroke:
    (*a*) Growth—Abundant.
    (*b*) Form—Spreading.
    (*c*) Elevation—Flat.
    (*d*) Luster—Glistening.
    (*e*) Topography—Smooth.
    (*f*) Odor—Absent.
    (*g*) Consistency—Membranose.
  2. Gelatine Stab:
    (*a*) Growth—Best at top.
    (*b*) Line of Puncture—Beaded.
    (*c*) Liquefaction—Saccate.
  3. Nutrient Broth:
    (*a*) Surface Growth—Ring.
    (*b*) Clouding—Abundant.
    (*c*) Odor—Absent.
    (*d*) Sediment—Abundant.
  4. Litmus Milk:
    (*a*) Alkaline.
    (*b*) Prompt Reduction.

5. Gelatine Colonies:
    (*a*) Growth—Slow.
    (*b*) Form—Irregular.
    (*c*) Elevation—Liquefying.
    (*d*) Liquefying—Spreading.
6. Agar Colonies:
    (*a*) Growth—Rapid—Temperature 87.6° F.
    (*b*) Form—Irregular.
    (*c*) Surface—Smooth.
    (*d*) Elevation—Flat.
    (*e*) Edge—Lacerate.
    (*f*) Internal Structure—Coarsely Granular.

III. Physical and Biochemical Features:
1. Fermentation tubes contain peptone, water, and
    (*a*) Dextrose: { Gas—Negative. Reaction—Neutral.
    (*b*) Saccharose: { Gas—Negative. Reaction—Slightly Acid.
    (*c*) Lactose: { Gas—Negative. Reaction—Neutral.
2. Indol Formation:
    (*a*) Positive.
3. Temperature Relations:
    (*a*) Not killed at 212 deg. Fahr. for five minutes.
    (*b*) Killed at 212 deg. Fahr. for eighteen minutes.
    (*c*) Killed at 225 deg. Fahr. for three minutes.

Organism H

This organism was found growing in swelled cans of peas.

I. Morphology:
1. Vegetative Cells:
    (*a*) Form—Long Rods.
    (*b*) Limits of size—5.8 × .9 microns.
    (*c*) Size of the majority—4.35 × 2.1 microns.
    (*d*) Ends—Rounded.

2. Endospores.
    (*a*) Position—Polar.
    (*b*) Form—Round.
    (*c*) Size—1.8 microns.
3. Flagella:
    (*a*) Positive.
4. Staining:
    (*a*) Gram—Positive.

II. Cultural Features:

1. Agar Stroke:
    (*a*) Growth—Scant.
    (*b*) Form—Spreading.
    (*c*) Elevation—Flat.
    (*d*) Luster—Glistening.
    (*e*) Topography—Smooth.
    (*f*) Odor—Absent.
    (*g*) Consistency—Slimy.
2. Gelatine Stab:
    (*a*) Growth—Best at top.
    (*b*) Line of Puncture—Beaded.
    (*c*) Liquefaction—Crateriform.
3. Nutrient Broth:
    (*a*) Surface Growth—Pellicle.
    (*b*) Clouding—None.
    (*c*) Odor—Absent.
    (*d*) Litmus Milk.
4. Litmus Milk:
    (*a*) Alkaline.
    (*b*) Prompt Reduction.
5. Gelatine Colonies:
    (*a*) Growth—Rapid.
    (*b*) Form—Irregular.
    (*c*) Elevation.
    (*d*) Liquefaction—Spreading.
6. Agar Colonies:
    (*a*) Growth—Rapid—Temperature 87.6° F.

(*b*) Form—Irregular.
(*c*) Surface—Smooth.
(*d*) Elevation—Flat.
(*e*) Edge—Lacerate.
(*f*) Internal Structure—Marmorated.

III. Physical and Biochemical Features:
1. Fermentation tubes containing peptone, water, and
(*a*) Dextrose: { Gas—Negative. Reaction—Neutral.
(*b*) Saccharose: { Gas—Negative. Reaction—Slightly Acid.
(*c*) Lactose: { Gas—Negative. Reaction—Neutral.
2. Indol Formation:
(*a*) Positive.
3. Temperature Relations:
(*a*) Not killed at 212 deg. Fahr. for ten minutes.
(*b*) Killed at 238 deg. Fahr. for five minutes.

Organism I

This organism was found growing in swelled cans of peas.
I. Morphology:
1. Vegetative Cells:
(*a*) Form—Short Rods.
(*b*) Limits of size—2.8 × 1.46 microns.
(*c*) Size of the majority—2.6 × 1.38 microns.
(*d*) Ends—Rounded.
2. Endospores.
(*a*) Position—Polar.
(*b*) Form—Round.
(*c*) Size—1 × .51 microns.
3. Flagella:
(*a*) Positive.
4. Staining:
(*a*) Gram—Positive.

II. Cultural Features:

1. Agar Stroke:
   (*a*) Growth—Scant.
   (*b*) Form—Spreading.
   (*c*) Elevation—Flat.
   (*d*) Luster—Glistening.
   (*e*) Topography—Smooth.
   (*f*) Odor—Absent.
   (*g*) Consistency—Slimy.

2. Gelatine Stab:
   (*a*) Growth—Best at top.
   (*b*) Line of Puncture—Filiform.
   (*c*) Liquefaction—None.

3. Nutrient Broth:
   (*a*) Surface Growth—Pellicle.
   (*b*) Clouding.
   (*c*) Odor—Absent.
   (*d*) Sediment—Abundant.

4. Litmus Milk:
   (*a*) Alkaline:
   (*b*) Prompt Reduction.

5. Gelatine Colonies:
   (*a*) Growth—Slow.
   (*b*) Form—Irregular.
   (*c*) Elevation—Flat.
   (*d*) Liquefying—None.

6. Agar Colonies:
   (*a*) Growth—Rapid—Temperature 80.6° F.
   (*b*) Form—Lobate-lobulate.
   (*c*) Surface—Smooth.
   (*d*) Elevation—Raised.
   (*e*) Edge—Lacerate.
   (*f*) Internal Structure—Finely Granular.

III. Physical and Biochemical Features:

1. Fermentation tubes containing peptone, water, and
   - (*a*) Dextrose: Gas—Negative. Reaction—Neutral.
   - (*b*) Saccharose: Gas—Negative. Reaction—Neutral.
   - (*c*) Lactose: Gas—Negative. Reaction—Neutral.
2. Indol Formation:
   - (*a*) Positive.
3. Temperature Relations:
   - (*a*) Not killed at 212 deg. Fahr. for ten minutes.
   - (*b*) Killed at 238 deg. Fahr. for five minutes.

The different kinds of bacteria that were found growing in swelled cans were studied as carefully as it was possible, and they have shown us the following facts: (*a*) That they are able to produce the decomposition of the products in which they grow; (*b*) that the time required to produce fermentation of the canned goods varies with the virulence of the bacteria, which may be increased when the temperature is favorable to their growth. The temperature and the time used for cooking fruits and vegetables are sufficient to kill most of microorganisms that may produce swells. However, one form of bacteria found in pears was not killed at 212 deg. Fahr., the temperature used in sterilization. If the operation of cooking fruits and vegetables is done very carefully, which may be considered as a complement of the preceding manipulations involved in the process of canning, the losses due to swells will be lowered to a minimum. The losses that occur in a canning plant are not only due to growth of organisms that survive the temperature of the cooker, but also to leaks which in time become swells. In this case, the losses cannot be attributed to lack of sterilization of the raw material, but to the defective work done by the capping machines. This reason alone will be enough to show the convenience of exercising a careful control of the work performed by the capping machines,

which should be inspected several times during the day. In relation to this fact, we want to call the attention of the canners to the matter of handling the cans. Would it be a hard operation for the canner to supply the help with cans taken directly from the crates, provided a careful inspection is made so as to detect defective cans?

Would it not be more advantageous for the canner to avoid the unloading and storage of the cans, before they are sent to the canning tables?

One may say that proceeding in this way would take very much room. It is true to a certain extent, but there will be a great saving in labor, because the decrease of leaks will be very noticeable. Besides this, the improvement in hygienic conditions that can be secured by giving more room to the place where the help does its work cannot be doubted. Whether spoilage of fruit be due to organisms which have resisted the process of sterilization or to infection from leaks, there is an absence of those forms known to be pathogenic or to cause disease. It was not possible to study this phase further except by making comparisons of form and cultural characteristics with descriptions given in the manuals for the determination of species. The acidity of the fruit or possibly other qualities in composition seem to make an unfavorable medium for the growth of disease-producing organisms. Very little is known concerning the decomposition produced by organisms found upon fruits. It is known in a general way that the fruit cells are broken down, that the sugars are destroyed and that the acidity is changed, usually to lactic acid. Whether poisonous products can be formed even in small quantity has not been determined directly, but the indirect evidence is overwhelmingly against the formation of ptomaines or toxins.

The mere absence of a conclusive relation between the use of a product and disease does not lessen the responsibility of the manufacturer in exercising every possible precaution to use only sound fruit, and to have it handled by healthy persons. The latter safeguard might extend to an insistence on medical inspection.

FIG. 44. A. Aspergillus. Molds from leaky cans

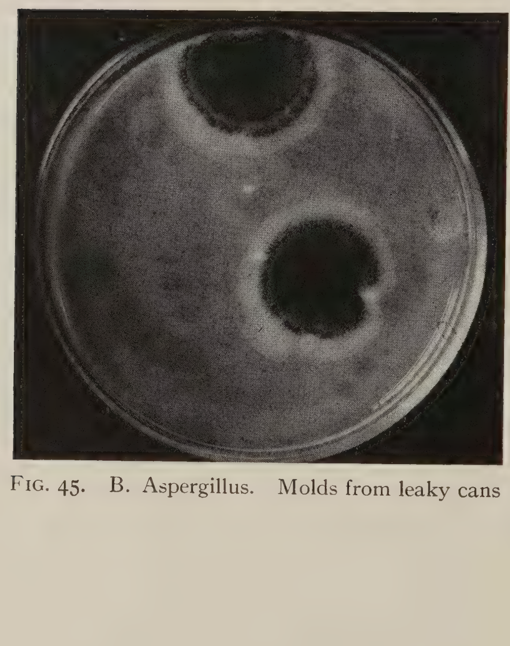


FIG. 45. B. Aspergillus. Molds from leaky cans

MOLDS FOUND GROWING IN LEAKY CANS

A.—Aspergillus.
B.—Aspergillus.
C.—Mucor.
D.—Mucor.
E.—Dark green Penicillium.
F.—Light Penicillium.

All of the above organisms were found growing in leaky cans of different fruits.

DESCRIPTION OF THE DIFFERENT YEASTS AND MOLDS FOUND GROWING IN LEAKY CANS

The yeasts found growing in leaky cans, which amounted to thirteen in number, were especially tested for death temperature. These yeasts were heated at 140 deg. Fahr. for ten minutes, plated and placed in the incubator at 29–33 degrees C. so as to stimulate their growth.

After three days incubation, none of the petri dishes that were inoculated showed signs of any kind of growth. As 140 deg. Fahr. is not a very high temperature, and one which can be obtained at the center of the cans very easily while cooking, the same specimens were submitted to a higher temperature. In the second test for death temperature, the yeasts were heated at 212 deg. Fahr. for five minutes. They were put under the same conditions as before, and none of them showed any signs of growth. In order to carry out a very definite test concerning the growth, spore formation, alcohol production, etc., we saved two specimens of yeasts with which we have carried out the following determinations:

Organism 1

Probable name—*S. Ellipsiodeous.*

This organism was found growing in leaky cans of different

FIG. 46. C. Mucor. Molds from leaky cans

FIG. 47. D. Mucor. Molds from leaky cans

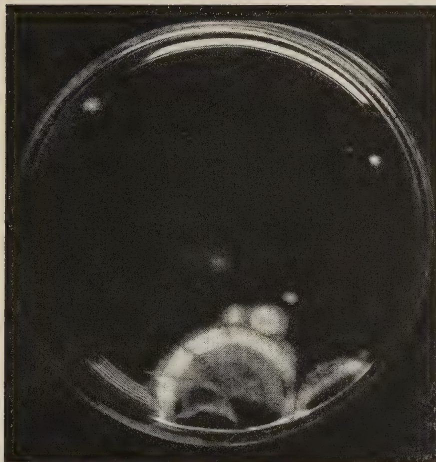


FIG. 48. E. Dark green penicillium. Molds from leaky cans

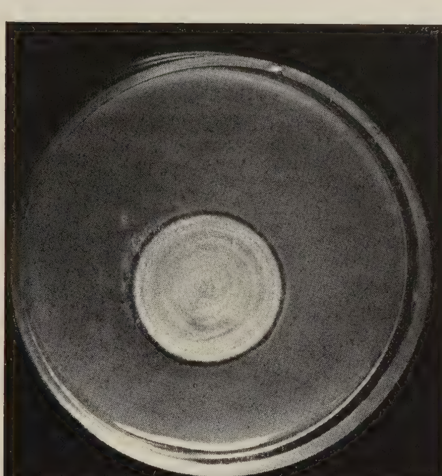


FIG. 49. F. Light green penicillium. Molds from leaky cans

kinds of fruits, and associated to it were found growing molds of the groups Penicillium, Aspergillus, and Mucor.

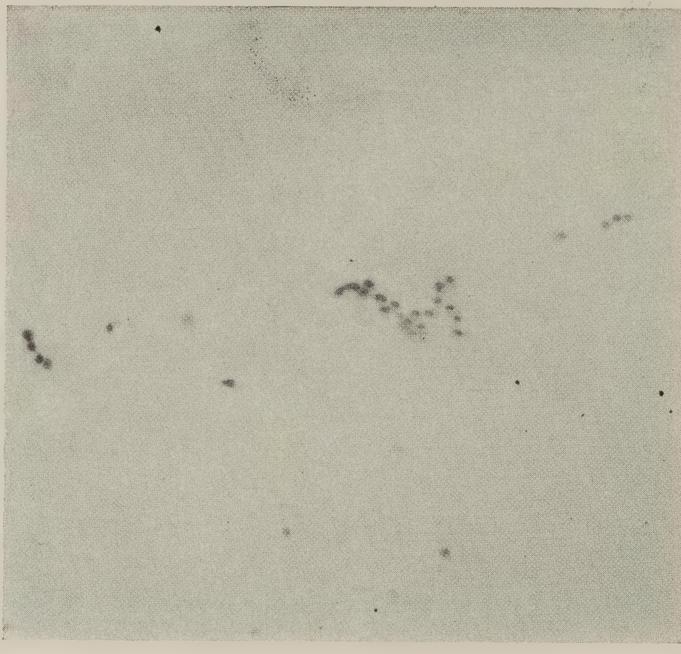


FIG. 50. Photomicrograph of organism 1. This yeast was found growing in leaky cans of different fruits

I. Morphology:

1. Vegetative Cells:
   - (*a*) Form—Ellipsoidal.
   - (*b*) Limits of size—8.41 × 5.51 microns.
   - (*c*) Size of the majority—5.8 × 3.77 microns.
   - (*d*) Spore formation—Begun after 22 hours of incubation at a temperature of 80.6 deg. Fahr. The rate increased at a temperature of 89.6 deg. Fahr.

II. Cultural Features:

1. Agar Colonies:
   - (*a*) Growth—Abundant.

(*b*) Form—Spreading.
(*c*) Elevation—Flat.

2. Liquid media:
(*a*) Surface Growth—Absent.
(*b*) Clouding—None.
(*c*) Sediment—Visci on agitation.

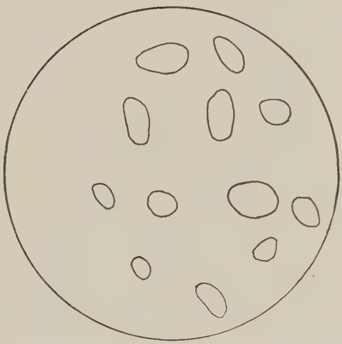


FIG. 51. Organism 1. Probable name *S. Ellipsiodeous.* This organism was found growing in leaky cans of different fruits

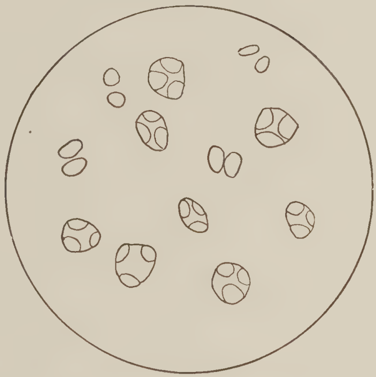


FIG. 52. Spores formation. *S. Ellipsiodeous*

3. Gelatine Colonies:
(*a*) Growth—Slow.
(*b*) Form—Irregular.
(*c*) Elevation—Flat.
(*d*) Liquefaction—None.

III. Biochemical and Physical Characteristics:
(*a*) Fermentation in grape must of 1.090 s.g.
(*b*) Alcohol formed—6.4 per cent.

IV. Temperature Relations:
(*a*) Not killed at 122 deg. Fahr. for ten minutes.
(*b*) Killed at 199.5 deg. Fahr. for ten minutes.

Organism 2

Probable name—*S. Pastorianos.*

This organism was found growing in leaky cans of different

kinds of fruits, and associated to it were found growing molds of the groups Penicillium, Aspergillus, and Mucor.

I. Morphology:

1. Vegetative Cells:
   (*a*) Form—Oblong.
   (*b*) Limits of size, 8.7 × 4.3 microns.
   (*c*) Size of the majority—4.35 × 2.9 microns.
   (*d*) Spore Formation—Begun after 22 hours of incubation at a temperature of 80.6 deg. Fahr. The rate increased at a temperature of 89.6 deg. Fahr.

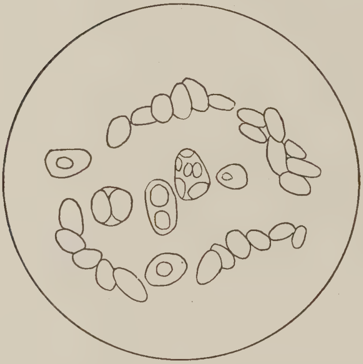


FIG. 53. Organism 2. Probable name *S. Pastorianos.* Spores formation. This organism was found growing in leaky cans of different fruits

II. Cultural Features:

1. Agar Colonies:
   (*a*) Growth—Abundant.
   (*b*) Form—Spreading.
   (*c*) Elevation—Flat.

2. Liquid Media:
   (*a*) Surface Growth—Absent
   (*b*) Clouding—None.
   (*c*) Sediment—Heavy brownish in color.

3. Gelatine Colonies:
   (*a*) Growth—Slow.
   (*b*) Form—Irregular.
   (*c*) Elevation—Flat.
   (*d*) Liquefaction—None.

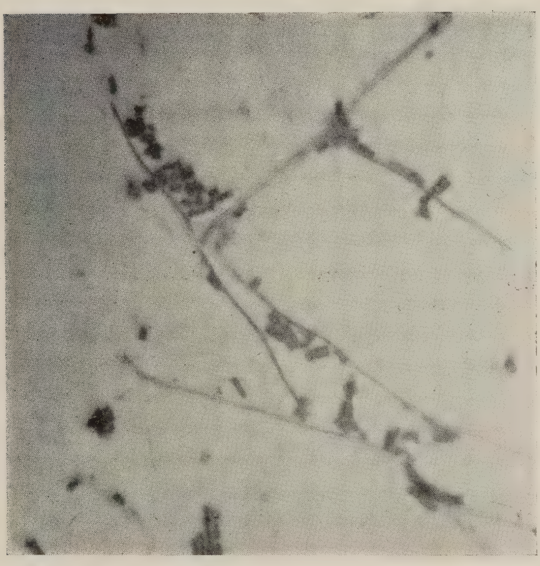


Fig. 54. Photomicrograph. *Oidium* sp.

III. Biochemical and Physical Characteristics:
   (*a*) Fermentation in grape must of 1.090 s.g.
   (*b*) Alcohol formed—3.7 per cent.

IV. Temperature Relations:
   (*a*) Not killed at 122 deg. Fahr. for ten minutes.
   (*b*) Killed at 199.5 deg. Fahr. for ten minutes.

Damage from yeast will not be likely if the cans are given the usual processing and do not develop leaks. As the yeasts are killed at temperatures far below that attained in sterilization, it is evident that any spoilage of canned fruit from yeast growth

FIG. 55. From leaky cans. *Oidium* sp.

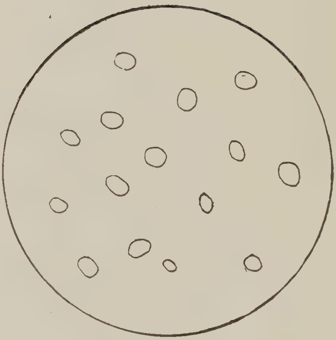


FIG. 56. From leaky cans. *Torula* sp.

FIG. 57. From leaky cans. *Micoderma vini* variety

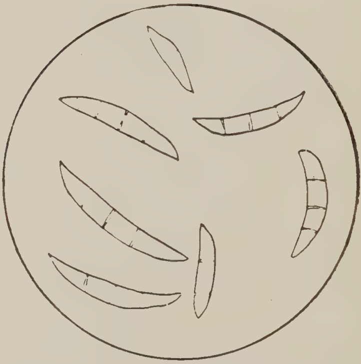


FIG. 58. From leaky cans. *Fusarium* sp.

must be due to action of yeasts that gain entrance through leaks of various kinds after the fruit has been sterilized.

The ellipsiodeous yeasts were very commonly found in spoiled cans of fruit, and one of this group was therefore taken for detailed study. Most of the other yeasts were sausage-shaped, and the one that appeared most often was chosen for study of its properties. Since all of the yeasts were killed at low temperatures, it was not deemed important to determine the properties of the other yeasts in detail.

PART FOUR

THE MAKING OF SANITARY CANS

THE MAKING OF SANITARY TIN CANS

HISTORICAL DATA

The first improvement in the tin can, adapting it especially to canning purposes, was made in 1823 by Pierre Antoine Angibert, a Frenchman. His improvement consisted in first putting the fruit in the can and covering it with a lid having a hole in it. The cans were set in a water-bath and boiled for some time, after which the hole was closed with a drop of solder.

All the early tin cans were made by what was known as the plumb joint—that is, the edges along the sides were butted together and soldered, as were also the two ends. The entire work was done with a pair of scissors and a soldering iron. Only a few cans could be made in a day, one hundred being considered a very large number for one workman. It was not until 1847 that Allen Taylor invented the stamped can with the extension edges. In 1849 the pressed top was added as an improvement.

From the beginning, bottles were too costly and broke too easily to be used for the cheaper articles of food. The earthenware jars were heavy and not sufficiently well glazed. The tin can lent itself to commercial purposes best, but it was expensive and the evolution of its manufacture was slow. At present it is manufactured by automatic machinery, at low cost and in enormous quantities.

The sanitary can in this country had its beginning with the Max Ams Preserving Company, of New York.

Mr. Ams engaged in the canning and packing business in 1868, and soon established a very large export business of American food products. He was an enterprising preserver of food products, and experienced all the difficulties that the old-fashioned canner experiences to-day. Mr. Ams was a very progressive man, and continually experimenting with not only

containers, but also with water-proof and oil-proof compounds for lining the outer rim of the cover, in order to obtain a perfectly air-tight can.

In 1888, his eldest son, Charles M. Ams, being a graduate chemist, took up the problems of the hermetical sealing of food products. At this time the can tops were either soldered on by hand, or a paper ring or rubber ring was used on the flange to make the can air-tight, if possible, by double-seaming. A double seamer of the hand type was in use in those days for seaming the bottoms on tin pails, canisters, and sheet-metal boxes, but that is not the style of seamer used to-day in the canning industry. There were almost as many leaky cans as there were perfect ones, and the loss through these was enormous. To overcome this great loss the experimenters sought the perfection of the sanitary can. Europe was experiencing the same difficulties, and the cans on that continent were crude affairs.

Charles M. Ams introduced the liquid compound for lining the outer rim of the cover, applying the compound by hand with a camel's-hair brush, afterward securing a patent on this compound.

It was after the introduction of this method that it became necessary to make a machine for lining the covers with this compound, and here Mr. Julius Brenzinger enters the field with a lining machine; and, on November 1, 1897, he filed his first patent for a lining machine, for applying the compound to the rim of the can covers.

The sanitary can was known in those days as the Max Ams can. Charles M. Ams christened it the "Sanitary Can," as it is known to-day and manufactured by the Sanitary Can Company and the American Can Company. He also first introduced the lacquered can by painting with a brush the inside of the cans and baking them before being used for canning lobsters, owing to the fact that lobsters contain a large percentage of sulphur, which acts upon the tin.

There are two systems for hermetically sealing tin cans. In the

one used in European countries, and also in this country, the can is sealed by crimping the top on to the flanged body, the sealing being made secure by a patented cement resembling rubber, above referred to. This is the Ams method, and is known throughout the wide world as the Sanitary Solderless Sealed Can, patented by the late Max Ams. This article has been on the market for the past fifteen years. This method has the advantage over the ordinary mode of soldering, as vegetables and fruits may be placed into the cans whole. There is positively no danger of acid or solder getting inside of the container, no danger from lead-poisoning, no scorching sugar or fruit, and no black spots in the syrup of the Sanitary Can.

The can that is mostly in use in California and throughout the Eastern United States is what is called the "Sanitary" can. This is what is termed a "lock body seamed can" with the bottoms double-seamed on and the top open until the fruit is placed therein, and then the top double-seamed on. The manufacture of these cans is a very important matter, yet at the same time is very simple.

The smallest plant which we recommend would be capable of turning out from 6,000 to 8,000 cans per day, packed, ready to be labeled. Such an outfit would cost about $2,000. Gross weight, ready for shipment, would be about 8,000 lbs. and 380 cubic feet. This equipment could be added to, making a single unit capable of turning out from 16,000 to 18,000 cans per day, and the total cost of the equipment would be about $5,000. Gross weight, ready for shipment, about 19,000 lbs. and about 1,000 cubic feet. Naturally, additional machines could be added as the business grew and warranted it. The smaller plant could be successfully operated by eight employees, mostly boys or girls; while the larger would have more automatic machines, and would not require so many employees. Floor space for the smaller outfit would be about 20 x 20 ft., and would require about 5 h. p. Floor space for the larger outfit would be about 20 x 30 ft. and would require from 8 to 10 h. p. These outfits are not only used for making sanitary cans for food products,

but they are also desirable for making tin cans for holding any other product, such as paints, oils, greases, powders, etc.

Having in mind the sanitary can as it is made in this country for food products, we shall describe the various operations necessary for making the cans as follows:

A can-maker buys the tin-plate of a certain weight or thick-

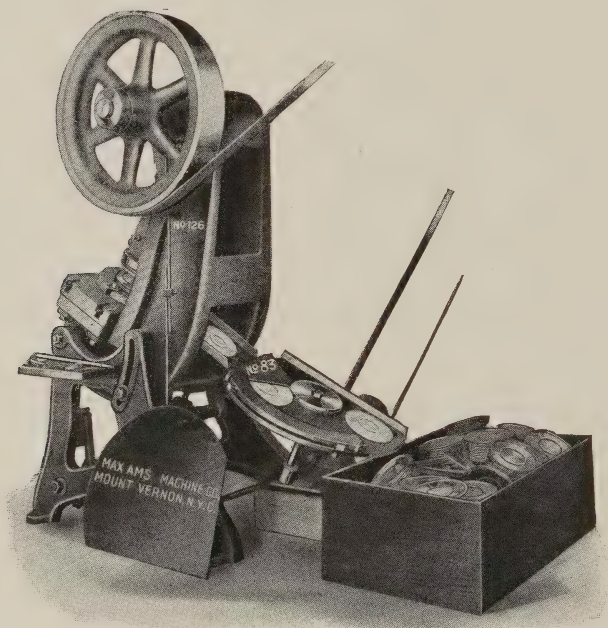


FIG. 59. Cover-curling machine.

SPECIFICATIONS

Net weight, 210 pounds.
Measurements over all: length, 2 feet; width, 20 inches; height, 20 inches.
Capacity, 16,000 ends per day of 10 hours.

ness, depending upon the size of can he desires to make, large cans requiring heavier tin-plate than small ones; the size of the cans also determines the size of the tin-plate which can be most economically used—that is, with the least amount of waste, the tin-plate being sold in different widths and lengths.

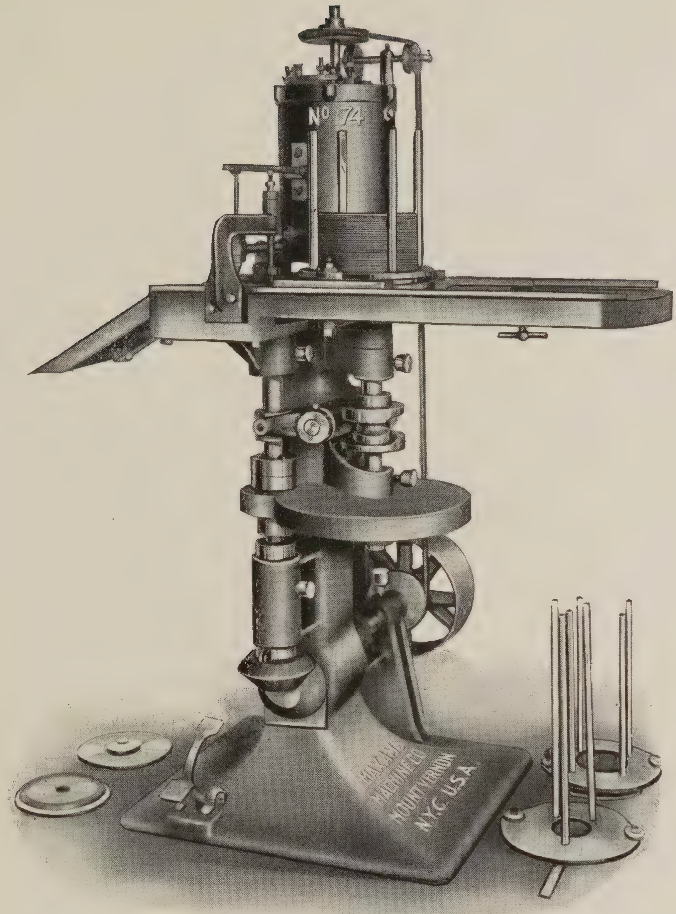


FIG. 60. Lining machine

SPECIFICATIONS

Net weight, 575 pounds.
Height, 4 feet 9 inches.
Floor space, 3 feet x 2 feet 6 inches.
Driving pulley, 10 inches.
Speed, 220 R.P.M. for 60 large diameter ends per minute.
Speed, 370 R.P.M. for 100 small diameter ends per minute.
Cubic measure, 75 feet (2 cbm.).
Gross weight, 725 pounds (335 kgs.).
Capacity, from 60 to 120 cans per minute, according to the size of the cover.

In explaining the process of making the cans under the different operations which follow, we shall consider that we want to make what is known as No. 3 "sanitary" cans, which are four and three-sixteenths inches diameter by about five inches high.

OPERATION No. 1

STAMPING OUT THE CAN ENDS

The tops and bottoms (or ends) of the cans, which are usually alike, but may be made differently, are stamped out of the tin-plate by means of a press and die. (See Fig. 59.)

OPERATION No. 2

APPLYING THE COMPOUND TO THE COVERS

The compound, which takes the place of solder for making the tops and bottoms air-tight, is then applied to the tops and bottoms by means of a lining machine. This is called "Lining the covers." From this machine the lined tops and bottoms are passed (automatically with some machines and by hand with others) into a dryer conveyor. This dryer conveyor evaporates the fluid in the compound and leaves it in a dry condition, sticking tightly to the covers. These tops and bottoms can be stamped out and lined in any quantity for future use, but should not be kept indefinitely. (See Fig. 60.)

OPERATION No. 3

CUTTING OUT THE BODY BLANKS

The body blanks for the bodies (cylinders of the can) are cut out of the tin-plate by means of either the squaring shears or a gang slitter machine, which shapes them into flat body blanks. (See Fig. 61.)

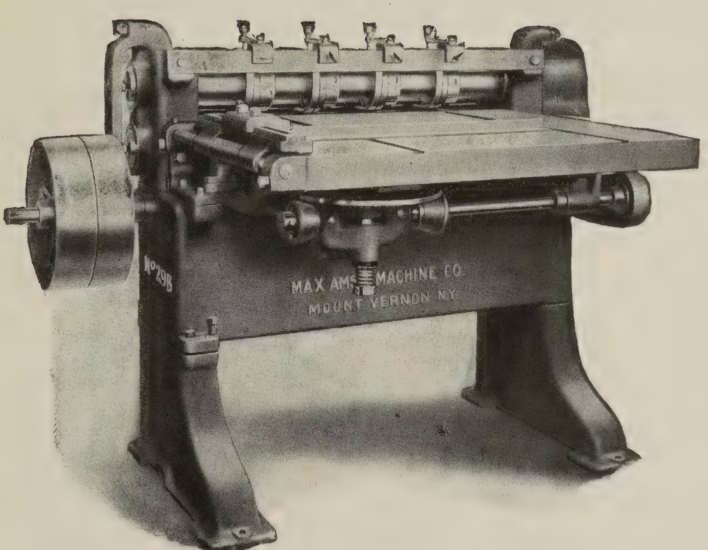


FIG. 61. Gang slitter

SPECIFICATIONS

Weight, complete with countershaft, 2,000 pounds.
Diameter of cutters, 6 inches.
Diameter of cutter shafts, 3 inches.
Maximum width between bearings, 35 inches.
Will handle sheets in width up to 32 inches.
Length of table (front to center of cutters), 33 inches.
Maximum number of cutters, 12.
Will slit sheet metal with 12 sets of cutters, thickness up to No. 26 B. W. G.
Will slit with 4 sets of cutters, thickness up to No. 24 B. W. G.
Diameter and face of driving pulley, 14 x 3 inches.
Speed of driving pulley, about 280 R. P. M.
Number of strokes of feed, per minute, 42.
Height from floor to feed table, 34 inches.
Floor-space base (F to B–R to L), 45 x 66 inches.
Cubic measure, 84 feet (2.4 cbm.), 900 kegs.
Capacity, about 50,000 body blanks per day of 10 hours.

OPERATION No. 4

FORMING THE BODY BLANKS INTO CYLINDERS

The body blanks are fed into a forming machine, this machine forming them into round bodies, but without the side edges fastened together. (See Fig. 62.)

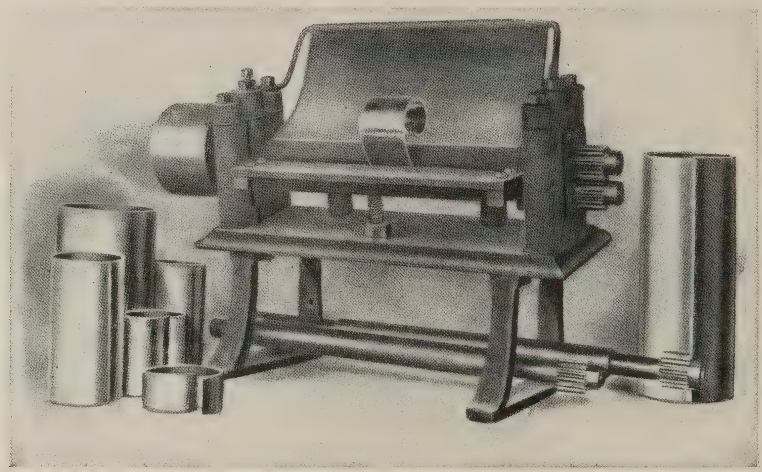


FIG. 62. Body-forming machine

SPECIFICATIONS

Driving pulley, 5 x 3 inches.
Speed, 700 to 800 R.P.M.
Capacity, 5,000 to 6,000 bodies per hour.

OPERATION No. 5

SIDE-SEAMING THE BODIES

The bodies are then ready to be side-seamed. This operation can be done by either hand or by a side-seaming machine, which automatically solders the side seam. Either method is recommended where the output is less than 20,000 cans per day, and is known as a "lap seam." (See Fig. 64.)

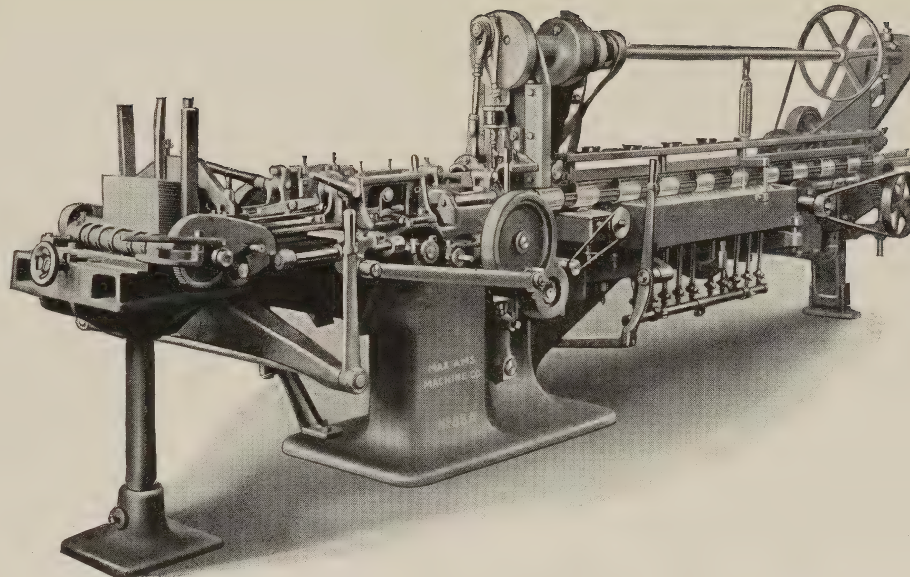


FIG. 63. Automatic can body-maker. 88A

SPECIFICATIONS

Will take work in diameter, 2½ inches to 4¼ inches
Will take up to (lengths) 6 inches
Diameter and width of flywheel, 21 inches x 3¼ inches
Revolutions per minute, 150–250.
Capacity per minute about, 75–125.

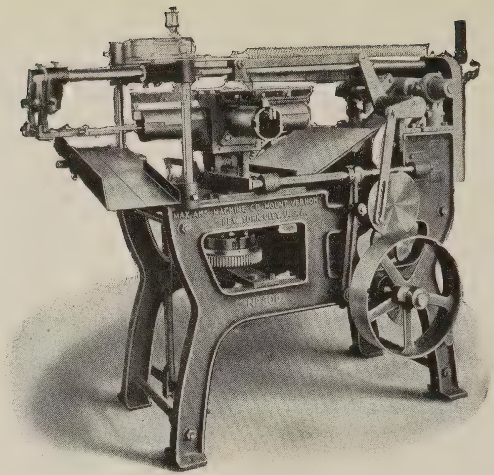


Fig. 64. Automatic lap-seam soldering machine

Specifications

Capacity, from 6,000 to 10,000 cans per day

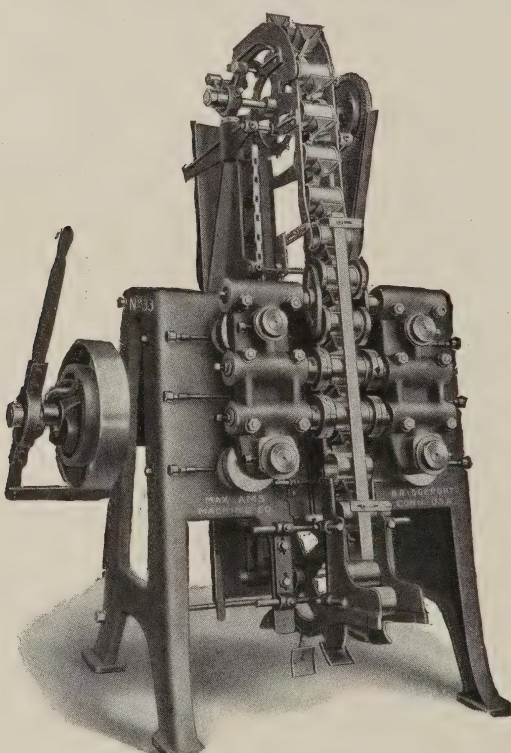


Fig. 65. Automatic can-flanger

Capacity, 150 cans per minute if desired

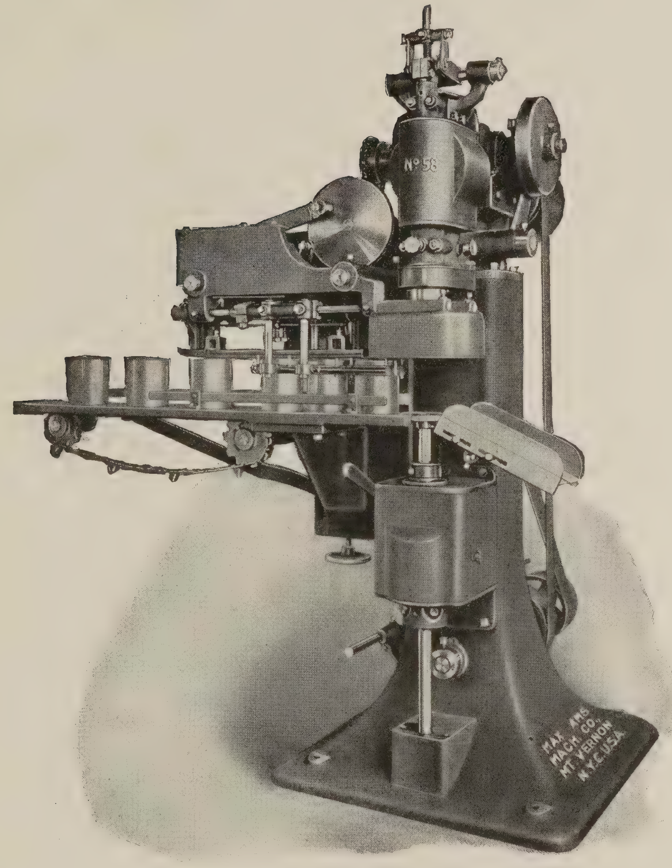


FIG. 66. Automatic double seamer

SPECIFICATIONS

Weight, about 2,200 pounds (990 kgs.).
Floor space, 2 feet 10 inches x 5 feet 5 inches.
Height, 6 feet 4 inches.
Driving pulleys, tight and loose, 8 inches or 12 inches x 3 inches.
Horse-power required, about 2.
Capacity, over 1,800 cans per hour.
Speed, about 620 R.P.M.

OPERATION No. 6

FLANGING THE ENDS OF THE BODIES

The bodies are then ready to be flanged on the ends. This means that the edges of the bodies are bent out at right angles, and this helps to form what is known as a double seam, during the seventh operation. (See Fig. 65.)

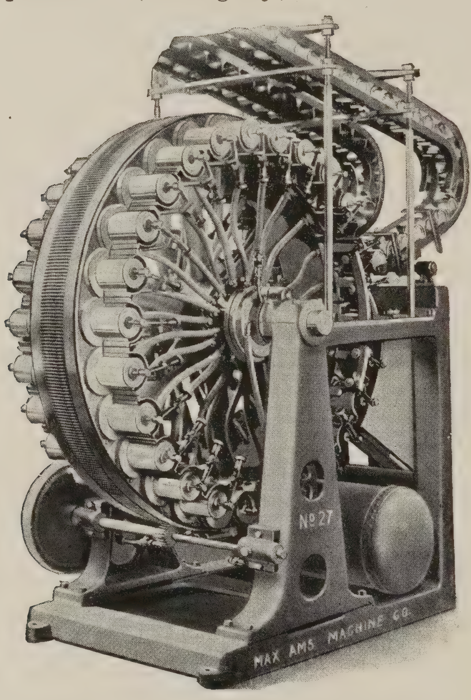


FIG. 67. Automatic can-testing machine
Capacity, 120 cans per minute

OPERATION No. 7

DOUBLE-SEAMING THE BOTTOMS TO THE CAN BODIES

The flanged bodies are then ready to have the bottoms double-seamed into them by means of a double-seaming machine.

The cans, with one end entirely open, are then ready to be filled, after which they are ready to be closed. (See Fig. 66.) After this step is completed, cans are tested for leaks. (See Fig. 67.)

OPERATION No. 8

DOUBLE-SEAMING THE COVERS ON THE CAN AFTER IT IS FILLED

It is better to have an extra double seamer for closing the cans after they are filled, although this can be done on the same double seamer which is used for putting on the bottoms. All of the above operations are so simple that boys or girls can be employed for the purpose. (See Fig. 66.)

APPENDIX

PURE FOODS ACT

APPENDIX

PURE FOODS ACT

An act for preventing the manufacture, sale or transportation of adulterated, mislabeled or misbranded foods and liquors, and regulating the traffic therein, providing penalties, establishing a State laboratory for foods, liquors and drugs, and making an appropriation therefor.

(Approved March 11, 1907; as amended 1909 and 1911.)

The people of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. The manufacture, production, preparation, compounding, packing, selling, offering for sale, or keeping for sale within the State of California, or the introduction into this State from any other State, Territory, or the District of Columbia, or from any foreign country, of any article of food or liquor which is adulterated, mislabeled or misbranded within the meaning of this act, is hereby prohibited. Any person, firm, company, or corporation who shall import or receive from any other State or Territory or the District of Columbia, or from any foreign country, or who having so received shall deliver for pay or otherwise, or offer to deliver to any other person, any article of food or liquor adulterated, mislabeled or misbranded within the meaning of this act, or any person who shall manufacture or produce, prepare or compound, or pack or sell, or offer for sale, or keep for sale, in the State of California any such adulterated, mislabeled or misbranded food or liquor shall be guilty of misdemeanor; *provided*, that no article of food shall be deemed adulterated, mislabeled or misbranded within the provisions of this act when prepared for export beyond the jurisdiction of the United States and prepared or packed according to specifications or directions of the foreign purchaser, when no substance is used

in the preparation or packing thereof in conflict with the laws of the foreign country to which said article is intended to be shipped; but if such foods shall be in fact sold, or kept or offered for sale for domestic uses and consumption, then this proviso shall not exempt said article from the operation of any provisions of this act.

SEC. 2. The term "food," as used in this act, shall include all articles used for food, drink, liquor, confectionery or condiment by man or other animals, whether simple, mixed, or compound.

SEC. 3. The standard of purity of food and liquor shall be that proclaimed by the Secretary of the United States Department of Agriculture.

SEC. 4. Food shall be deemed adulterated within the meaning of this act, in any of the following cases:

First. If any substance has been mixed or packed, or mixed and packed with the food so as to reduce or lower or injuriously affect its quality, purity, strength, or food value.

Second. If any substance has been substituted wholly or in part for the article of food.

Third. If any essential or any valuable constituent or ingredient of the article of food has been wholly or in part abstracted.

Fourth. If it be mixed, colored, powdered, coated, or stained in any manner whereby damage or inferiority is concealed.

Fifth. If it contain any added poisonous or other added deleterious ingredient.

Sixth. If it consist in whole or in part of a filthy, decomposed or putrid animal or vegetable substance, or any portion of an animal or vegetable unfit for food, whether manufactured or not, or if it is the product of a diseased animal, or one that has died otherwise than by slaughter; *provided*, that an article of liquor shall not be deemed adulterated, mislabeled or misbranded if it be blended or mixed with like substances so as not to injuriously reduce or injuriously lower or injuriously affect its quality, purity, or strength.

Seventh. In the case of confectionery: If it contains terra alba, barytes, talc, chrome yellow, or other mineral substance or poisonous color or flavor, or other ingredient deleterious or detrimental to health, or any vinous, malt, or spirituous liquor or compound or narcotic drug.

Eighth. In the case of vinegar: If it be artificially colored.

Ninth. If it does not conform to the standard of purity therefor as proclaimed by the Secretary of the United States Department of Agriculture.

Sec. 5. That the term "misbranded," as used herein, shall apply to all articles of food, or articles which enter into the composition of food, the package or label of which shall bear any statement, design, or device regarding such article, or the ingredients or substances contained therein which shall be false or misleading in any particular, and to any food product which is falsely branded as to the State, Territory, District of Columbia, city, town, or foreign country in which it is manufactured or produced.

Sec. 6. Food and liquor shall be deemed mislabeled or misbranded, within the meaning of this act, in any of the following cases:

First. If it be an imitation of, or offered for sale under the distinctive name of another article of food.

Second. If it be labeled or branded or colored so as to deceive or mislead, or tend to deceive or mislead the purchaser; or if it be falsely labeled in any respect, or purport to be a foreign product when not so, or if the contents of the package as originally put up shall have been removed in whole or in part, and other contents shall have been placed in such package.

Third. If in package form, and the contents are stated in terms of weight or measure, they are not plainly and correctly stated on the outside of the package.

Fourth. If the package containing it or its label shall bear any statement, design, or device regarding the ingredients or the substance contained therein, which statement, design, or device shall be false or misleading in any particular.

Fifth. When any package bears the name of the manufacturers, jobbers, or sellers, or the grade or class of the product, it must bear the name of the real manufacturers, jobbers, or sellers and the true grade or class of the product, the same to be expressed in clear and distinct English words in legible type; *provided*, that an article of food shall not be deemed misbranded, if it be a well-known food product of a nature, quality, and appearance, and so exposed to public inspection as not to deceive or mislead nor tend to deceive or mislead a purchaser, and not of the character included within the definitions one to four of this section.

Sixth. If, having no label, it is an imitation or adulteration, or is sold or offered for sale under a name, designation, description, or representation which is false or misleading in any particular whatever; and in case of eggs and poultry, if they have been kept or packed in cold storage, or otherwise preserved, they must be so indicated by written or printed label or placard plainly designating such fact when offered or exposed for sale.

Sec. 7. The term "package," as used in this act, shall be construed to include any phial, bottle, jar, demijohn, carton, bag, case, can, box or barrel, or any receptacle, vessel or container of whatsoever material or nature which may be used by a manufacturer, producer, jobber, packer or dealer, for inclosing any article of food.

Sec. 8. The possession of any adulterated, mislabeled or misbranded article of food or liquor by any manufacturer, producer, jobber, packer or dealer in food, or broker, commission merchant, agent, employee or servant of any such manufacturer, producer, jobber, packer or dealer, shall be *prima facie* evidence of the violation of this act.

Sec. 9. For the purposes of this act there is hereby established a State laboratory for the analysis and examination of foods and drugs, which shall be under the supervision of the State Board of Health, which laboratory shall be located at such place as the State Board of Health may select.

The State Board of Health shall appoint a director of said

laboratory, and an assistant to such director, both of whom shall be skilled pharmaceutical chemists and analysts of foods and drugs. Said director shall perform all duties required by this act and which shall be required by the State Board of Health. The assistant shall be under the supervision of the director, and shall perform all duties required of him by the director and by the State Board of Health.

The director shall receive an annual salary of three thousand dollars, and the assistant shall receive an annual salary of fifteen hundred dollars. All such salaries shall be paid in the same manner and at the same time as the salaries of State officers.

The State Board of Health, out of the appropriation hereinafter provided, and out of the funds derived from the operation of this act, may employ and fix the compensation of other and additional clerical and professional assistants.

Sec. 10. The State Board of Health, or its secretary, shall cause to be made by the said director of the State Laboratory, examinations and analyses of food and liquor on sale in California, suspected of being adulterated, mislabeled or misbranded, at such times and places and to such extent as said Board or its secretary may determine, and may appoint such agent or agents, as it may deem necessary, and the sheriffs of the respective counties of the State are hereby appointed and constituted agents for the enforcement of this act, and any agent or sheriff shall have free access, at all reasonable hours, for the purpose of examining any place where it is suspected that any article of adulterated, mislabeled or misbranded foods exists, and such agent or sheriff upon tendering the market price of said articles, if a sale be refused, may take from any person, firm or corporation samples of any articles suspected of being adulterated, mislabeled or misbranded, and shall deliver or forward such samples to the said director of the State Laboratory for examination and analysis.

Sec. 11. It shall be the duty of the State Board of Health, whenever it has satisfactory evidence of the violation of any

of the provisions of this act respecting the adulteration or misbranding of foods to report such facts to the district attorney of the county where the law is violated, after the hearing provided in section sixteen of this act.

Sec. 12. It shall be a misdemeanor for any person to refuse to sell to any sheriff or other agent of the State Board of Health any sample of food or liquor upon tender of the market price therefor, or to conceal any such food from such officer, or to withhold from him information where such food is kept or stored. Any such person so refusing to sell, or concealing such food, or withholding such information from said officer shall, upon conviction, be punished as provided in section nineteen of the Penal Code of the State of California.

Sec. 13. Whenever said director shall find from his examination and analysis that adulterated, mislabeled or misbranded food has been on sale in this State, he shall forthwith report to the Secretary of the State Board of Health.

Sec. 14. Every certificate signed by the said director of the State Laboratory shall be *prima facie* evidence of the facts therein stated.

Sec. 15. The said director of the State Laboratory shall make an annual report to the State Board of Health, on or before August first of each year, upon adulterated or misbranded foods and liquors, in which report shall be included the list of cases examined by him in which adulterants were found, and the list of articles found, mislabeled or misbranded, and the names of the manufacturers, producers, jobbers and sellers. Said report, or any part thereof, may, in the discretion of the State Board of Health, be included in the report which the State Board of Health is already authorized by law to make to the Governor. The State Board of Health may, in its discretion, publish any part of said report in any issue of its monthly bulletin.

Sec. 16. When an examination or analysis of the director of the State Laboratory shows that any of the provisions of this act have been violated, notice of that fact, together with

a copy of the certificate of the findings, shall be furnished to the party or parties from whom the sample was obtained or who executed the guaranty as provided in this act, and a date shall be fixed by the secretary of the State Board of Health at which said party or parties may be heard before the State Board of Health or before any two members thereof and the secretary. The hearing shall be held in the city of Sacramento, and at least fifteen days' notice thereof shall be first served upon the party complained of. These hearings shall be private and confined to questions of fact. Parties interested therein may appear in person or by attorney, and may propound interrogatories and submit oral or written evidence to show any fault or error in the findings made by the director of the State Laboratory. If the examination or analysis be found correct, or if the party or parties fail to appear at such hearing after notice duly served as provided herein, the secretary of the State Board of Health shall forthwith transmit a certificate of the facts so found to the district attorney of the county in which said adulterated, mislabeled or misbranded food was found. No publication as in this act provided shall be made until after said hearing is concluded.

SEC. 17. It is hereby made the duty of the sheriff of any county of this State, on presentation to him of a verified complaint of the violation of any provisions of this act, at once to obtain by purchase a sample of the adulterated, mislabeled or misbranded food complained of, and divide said article into three parts, and each part shall be sealed by the sheriff with a seal provided for that purpose. If the package be less than four pounds, or in volume less than two quarts, three packages of approximately the same size shall be purchased and the marks and tags upon each package noted as above. One sample shall be delivered to the party from whom procured, or to the party guaranteeing such merchandise, one sample shall be sent to the director of the State Laboratory, and the third sample shall be sent to and held under seal by the State Board of Health.

SEC. 18. For his services hereunder, the said sheriff shall be

allowed the same fees for travel allowed by law to sheriffs on service of criminal process, together with such compensation as by the board of supervisors of his county may be deemed reasonable, and all amounts expended by him in procuring and transmitting the said samples, which fees and amount expended shall be audited and allowed by the said supervisors and paid by his said county as other bills of said sheriff.

Sec. 19. It shall be the duty of the district attorney of each county to prosecute all violations of the provisions of this act occurring within his county.

Sec. 20. Any person, firm, company or corporation violating any of the provisions of this act shall be guilty of a misdemeanor, and, upon conviction, shall be punished by a fine of not less than five dollars, nor more than five hundred dollars, or shall be imprisoned in the county jail for a term not exceeding six months, or by both such fine and imprisonment. Food found to be adulterated, mislabeled or misbranded, within the meaning of this act, may, by order of any court or judge, be seized and destroyed.

Sec. 21. One-half of all fines collected by any court or judge, for the violations of the provisions of this act, shall be paid to the State Treasurer, and the State Treasurer shall deposit such money to the credit of the fund for the maintenance of the State Laboratory, to be drawn against by warrants of the State Controller upon claims which shall be approved by the State Board of Health and by the State Board of Examiners.

Sec. 22. No dealer shall be prosecuted under the provisions of this act, when he can establish a guaranty signed by the wholesaler, jobber, manufacturer, or other party residing in the United States from whom he purchased such article, to the effect that the same is not adulterated, mislabeled or misbranded within the meaning of this act, designating it, and can also establish by satisfactory evidence that the article sold by him was mislabeled, and that at the time of making such sale he was not aware of that fact. Said guaranty, to afford protection, must contain the name and address of the party or parties making

the sales of such article to said dealer, and an itemized statement showing the articles purchased; or a general guaranty may be filed with the secretary of the United States Department of Agriculture by the manufacturer, wholesaler, jobber or other party in the United States, and be given a serial number, which number shall appear on each and every package of goods sold under such guaranty with the words "guaranteed under the food and drugs act, June 30, 1906." In case the wholesaler, jobber, manufacturer or other party making such guaranty to said dealer resides without this State, and it appears from the certificate of the director of the State Laboratory that such article or articles were adulterated, mislabeled or misbranded, within the meaning of this act, or the national pure food act, approved June 30, 1906, the district attorney must forthwith notify the attorney general of the United States of such violation.

SEC. 23. The sum of twenty thousand dollars ($20,000.00) is hereby appropriated out of any money in the State treasury not otherwise appropriated for the purchase of equipment, apparatus, chemicals and supplies of said laboratory, and of the office expenses in connection with the same and for the compensation of additional assistants and other necessary help. The State Controller is hereby authorized to draw his warrants for the sums herein appropriated in favor of the secretary of the State Board of Health, and the State Treasurer is hereby directed to pay the same.

SEC. 24. No article of food as herein defined shall be manufactured or produced in violation of this act from and after the first day of July, nineteen hundred and seven.

SEC. 25. All acts and parts of acts in conflict or inconsistent with this act are hereby repealed.

SEC. 26. This act shall be in force and effect from and after the first day of January, nineteen hundred and eight.

STANDARDS OF PURITY

FRUIT AND VEGETABLES

(*a*) Fruit and Fruit Products

(Except fruit juices, fresh, sweet and fermented, and vinegars.)

1. *Fruits* are the clean, sound, edible, fleshy fructifications of plants, distinguished by their sweet, acid, and ethereal flavors.

2. *Dried fruit* is the clean, sound product made by drying mature, properly prepared, fresh fruit in such a way as to take up no harmful substance, and conforms in name to the fruit used in its preparation; *sun-dried fruit* is dried fruit made by drying without the use of artificial means; *evaporated fruit* is dried fruit made by drying with the use of artificial means.

3. *Evaporated apples* are evaporated fruit made from peeled and cored apples, and contain not more than twenty-seven (27) per cent of moisture determined by the usual commercial method of drying for four (4) hours at the temperature of boiling water.

4. *Canned fruit* is the sound product made by sterilizing clean, sound, properly matured and prepared fresh fruit, by heating, with or without sugar (sucrose) and spices, and keeping in suitable, clean, hermetically sealed containers, and conforms in name to the fruit used in its preparation.

5. *Preserve* is the sound product made from clean, sound, properly matured and prepared fresh fruit and sugar (sucrose) syrup, with or without spices or vinegar, and conforms in name to that of the fruit used, and in its preparation not less than forty-five (45) pounds of fruit are used to each fifty-five (55) pounds of sugar.

6. *Honey preserve* is preserve in which honey is used in place of sugar (sucrose) syrup.

7. *Glucose preserve* is preserve in which a glucose product is used in place of sugar (sucrose) syrup.

8. *Jam, marmalade,* is the sound product made from clean,

sound, properly matured and prepared fresh fruit and sugar (sucrose), with or without spices or vinegar, by boiling to a pulpy or semi-solid consistence, and conforms in name to the fruit used, and in its preparation not less than forty-five (45) pounds of fruit are used to each fifty-five (55) pounds of sugar.

9. *Glucose jam, glucose marmalade,* is jam in which a glucose product is used in place of sugar (sucrose).

10. *Fruit butter* is the sound product made from fruit juice and clean, sound, properly matured and prepared fruit, evaporated to a semi-solid mass of homogeneous consistence, with or without the addition of sugar and spices or vinegar, and conforms in name to the fruit used in its preparation.

11. *Glucose fruit butter* is fruit butter in which a glucose product is used in place of sugar (sucrose).

12. *Jelly* is the sound, semi-solid, gelatinous product made by boiling clean, sound, properly matured and prepared fresh fruit with water, concentrating the expressed and strained juice, to which sugar (sucrose) is added, and conforms in name to the fruit used in its preparation.

13. *Glucose jelly* is jelly in which a glucose product is used in place of sugar (sucrose).

(*b*) Vegetables and Vegetable Products

1. *Vegetables* are the succulent, clean, sound, edible parts of herbaceous plants used for culinary purposes.

2. *Dried vegetables* are the clean, sound products made by drying properly matured and prepared vegetables in such a way as to take up no harmful substance, and conform in name to the vegetables used in their preparation; *sun-dried vegetables* are dried vegetables made by drying without the use of artificial means; evaporated vegetables are dried vegetables made by drying with the use of artificial means.

3. *Canned vegetables* are sound, properly matured and prepared fresh vegetables, with or without salt, sterilized by heat, with or without previous cooking in vessels from which they take up no metallic substance, kept in suitable, clean, hermetically

sealed containers, are sound and conform in name to the vegetables used in their preparation.

4. *Pickles* are clean, sound, immature cucumbers, properly prepared, without taking up any metallic compound other than salt, and preserved in any kind of vinegar, with or without spices. *Pickled onions*, *pickled beets*, *pickled beans*, and other pickled vegetables are vegetables prepared as described above, and conform in name to the vegetables used.

5. *Salt pickles* are clean, sound, immature cucumbers preserved in a solution of common salt, with or without spices.

6. *Sweet pickles* are pickled cucumbers or other vegetables in the preparation of which sugar (sucrose) is used.

7. *Sauerkraut* is clean, sound, properly prepared cabbage, mixed with salt, and subjected to fermentation.

8. *Catchup* (*ketchup*, *catsup*) is the clean, sound product made from the properly prepared pulp of clean, sound, fresh, ripe tomatoes, with spices and with or without sugar and vinegar; *mushroom catchup*, *walnut catchup*, etc., are catchups made as above described, and conform in name to the substances used in their preparation.

FOOD SANITATION ACT OF MARCH 6, 1909

SECTION 1. Every building, room, basement or cellar occupied or used as a bakery, confectionery, cannery, packing house, slaughter-house, restaurant, hotel, grocery, meat market, or other place or apartment used for the production, preparation for sale, manufacture packing, storage, sale or distribution of any food shall be properly lighted, drained, plumbed and ventilated, and conducted with strict regard to the influence of such conditions upon the health of the operatives, employees, clerks or other persons therein employed, and the purity and wholesomeness of the food therein produced, kept, handled or sold; and for the purpose of this act the term "food" shall

include all articles used for food, drink, confectionery or condiment, whether simple or compound, and all substances and ingredients used in the preparation thereof.

SEC. 2. The floors, side walls, ceilings, furniture, receptacles, utensils, implements and machinery of every establishment or place where food is manufactured, packed, stored, sold or distributed shall at no time be kept in an unclean, unhealthful or unsanitary condition; and for the purposes of this act, unclean, unhealthful and unsanitary conditions shall be deemed to exist if food in the process of manufacture, preparation, packing, storing, sale or distribution is not securely protected from flies, dust, dirt, unsanitary conditions, and, as far as may be necessary, by all reasonable means from all other foreign or injurious contamination; and if the refuse, dirt and the waste products subject to decomposition and fermentation incident to the manufacture, preparation, packing, storing, selling and distributing of food are not removed daily; and if all trucks, trays, boxes, baskets, buckets, and other receptacles, chutes, platforms, racks, tables, shelves, and all knives, saws, cleavers, and all other utensils, receptacles, and machinery used in moving, handling, cutting, chopping, mixing, canning, and all other processes used in the preparation of food, are not thoroughly cleaned daily, and if the clothing of operatives, employees, clerks, and other persons therein employed is unclean, or if they dress or undress, or leave or store their clothing therein.

SEC. 3. The side walls and ceilings of every bakery, confectionery, hotel and restaurant kitchen shall be well plastered, or ceiled, with metal or lumber, or shall be oil-painted or kept well lime-washed, or otherwise kept in a good sanitary condition, and all interior woodwork of every bakery, confectionery, hotel or restaurant kitchen shall be kept well oiled or painted with oil paint, and be kept washed clean with soap and water or otherwise kept in a good sanitary condition; and every building, room, basement or cellar occupied or used for the preparation, manufacture, packing, storage, sale or distribution of food shall have an impermeable floor made of cement or tile laid in cement,

brick, wood or other suitable non-absorbent material which can be flushed and washed clean with water.

Sec. 4. The doors, windows and other openings of every food-producing or distributing establishment, where practicable, shall be fitted with stationary or self-closing screen doors and wire window screens, of not coarser than fourteen-mesh wire gauze.

Sec. 5. Every building, room, basement or cellar occupied or used for the preparation, manufacture, packing, canning, sale or distribution of food shall have convenient toilet or toilet rooms, separate and apart from the room or rooms where the process of production, manufacture, packing, canning, selling or distributing is conducted. The floors of such toilet rooms shall be of cement, tile laid in cement, wood, brick or other non-absorbent material, and shall be washed and scoured daily. Such toilets shall be furnished with separate ventilating pipes or flues, discharging into soil pipes, or on the outside of the building in which they are situated. Lavatories and washrooms shall be adjacent to toilet rooms, and shall be supplied with soap, running water and towels, and shall be maintained in a clean and sanitary condition. Operatives, employees, clerks and all persons who handle the material from which food is prepared, or the finished product, before beginning work, and immediately after visiting a toilet or lavatory, shall wash their hands and arms thoroughly in clean water.

Sec. 6. Cuspidors, for the use of operatives, employees, clerks and other persons, shall be provided, and each cuspidor shall be emptied and washed out daily with disinfectant solution and not less than five ounces of such solution shall be left in each cuspidor while in use. No operative, employee, clerk or other person shall expectorate or discharge any substance from his nose or mouth, on the floor or interior side wall of any building, room, basement, or cellar where the production, manufacture, packing, storing, preparation or sale of any food product is conducted.

Sec. 7. No person shall be allowed to, nor shall he, reside

or sleep in any room of a bake shop, public dining-room, hotel or restaurant kitchen, confectionery, or other place where food is prepared, produced, manufactured, served or sold.

Sec. 8. No employer shall require, permit or suffer any person to work, nor shall any person work, in a building, room, basement, cellar, place or vehicle, occupied or used for the production, preparation, manufacture, packing, storage, sale, distribution or transportation of food, who is afflicted or affected with any venereal disease, smallpox, diphtheria, scarlet fever, yellow fever, tuberculosis, consumption, bubonic plague, Asiatic cholera, leprosy, trachoma, typhoid fever, epidemic dysentery, measles, mumps, German measles, whooping-cough, chicken-pox, or any other infectious or contagious disease.

Sec. 9. The members of the State Board of Health, inspectors and agents appointed by said board, and all local health officers and inspectors shall have full power at all times to enter every building, room, basement, cellar, or any place occupied or used, or suspected of being occupied or used, for the production, manufacture, preparation, storage, sale or distribution of food, and to inspect the premises and all utensils, implements, receptacles, fixtures, furniture and machinery used as aforesaid, and if, upon inspection, any such building, room, basement, cellar, or any such place, vehicle, employer, operative, employee, clerk, driver, or other person, is found to be in violation or violating any of the provisions of this act, or if the production, preparation, manufacture, packing, storing, sale or distribution of food is being conducted in a manner detrimental to the health of the employees or operatives or to the character or quality of the food therein being produced, manufactured, packed, stored, sold, distributed or conveyed, the officer or inspector making the examination shall at once make a written report of the same to the district attorney of the county who shall prosecute all persons violating any of the provisions of this act, and also to the State Board of Health. The State Board of Health, from time to time, as in its discretion it may determine, may publish such reports in its monthly bulletin.

SEC. 10. All buildings, rooms, basements, cellars and other places and things kept, maintained or operated, which are in violation of the provisions of this act or any of them, and all food produced, prepared, manufactured, packed, stored, kept, sold, distributed or transported in violation of the provisions of this act or any of them, are hereby declared to be public nuisances, dangerous to health. Such nuisances may be abated or enjoined, in an action brought for that purpose by the local or State Board of Health, or they may be summarily abated in the manner provided by law for the summary abatement of public nuisances dangerous to health.

SEC. 11. Any person, firm or corporation, whether as principal or agent, employer or employee, who violates any of the provisions of this act shall be guilty of a misdemeanor, and each day that conditions or actions, in violation of this act, shall continue, shall be deemed to be a separate and distinct offense, and for each offense, upon conviction, he shall be punished by a fine of not less than twenty-five dollars nor more than five hundred dollars, or shall be imprisoned in the county jail for a term not exceeding six months, or by both such fine and imprisonment.

(Statutes of 1909, page 151.)

Section 9, as amended.

(Approved April 23, 1915)

For the purpose of this act there is hereby established a State laboratory for the analysis and examination of foods and drugs, which shall be under the supervision of the State Board of Health, which laboratory shall be located at such place as the State Board of Health may select. The State Board of Health shall appoint a director of said laboratory, a consulting nutrition expert, and an assistant to such director, all of whom shall be skilled pharmaceutical chemists and analysts of food and drugs. Said director shall perform all duties required by this act and which shall be required by the State Board of Health. Said consulting nutrition expert shall at all times be ready for con-

sultation with, give advice to, and perform duties in connection with the director of said laboratory, and shall at all times be under the supervision of and perform such duties under this act as are required by the State Board of Health. As a part of his duties he shall consult and advise with the State board of control concerning standards of purity and other matters relating to foods and drugs purchased by the State of California for any or all of its institutions. The assistant shall be under the supervision of the director and shall perform all duties required of him by the director and by the State Board of Health.

The director shall receive an annual salary of three thousand dollars, the consulting nutrition expert shall receive an annual salary of one thousand dollars, and the assistant to the director shall receive an annual salary of fifteen hundred dollars. All such salaries shall be paid in the same manner and at the same time as the salaries of State officers. The State Board of Health, out of the appropriation hereinafter provided, and out of the funds derived from the operation of this act, may employ and fix the compensation of other and additional clerical and professional assistants.

Section 22 was amended as follows:

No dealer shall be prosecuted under the provisions of this act when he can establish a guaranty signed by the wholesaler, jobber, manufacturer or other party residing in the United States from whom he purchased such article, to the effect that the same is not adulterated, mislabeled or misbranded within the meaning of this act, and can also establish by satisfactory evidence that the article sold by him was mislabeled and that at the time of making such sale he was not aware of that fact; such guaranty may be either general or special. A general guaranty shall guarantee without condition or restriction all of the products or articles produced, prepared, compounded, packed, distributed, or sold by the guarantor as not adulterated within the meaning of this act. A special guaranty shall guarantee in the same manner the particular articles listed in an invoice of the same, and shall be attached to or shall fully identify such invoice. Both said

guaranties to afford protection must contain the name and address of the party or parties making the sales of such article to said dealer. If the guaranty be to the effect that such article is not adulterated, mislabeled, or misbranded within the meaning of the national pure food act, approved June 30, 1906, it shall be sufficient for the purposes of this act and have the same force and effect as though it referred to this act, except that a guaranty referring to the said national pure food act alone shall not be sufficient for the purposes of this act in any case where at any time the standard for the article concerned under this act is higher than the standard for a like article under said national pure food act. In case the wholesaler, jobber, manufacturer or other party making such guaranty to said dealer resides without this State and it appears from the certificate of the director of the State laboratory that such article or articles were adulterated, mislabeled or misbranded, within the meaning of this act or the national pure food act approved June 30, 1906, the district attorney must forthwith notify the attorney general of the United States of such violation.

SEC. 3. The provisions of section 2 of this act shall be in force and effect from and after May 1, 1916; *provided*, that as to products packed and labeled prior to May 1, 1916, in accordance with said national pure food act, and with the regulations thereunder in force prior to May 5, 1914, the provisions of section 2 of this act shall be in force and effect from and after November 1, 1916.

An act to amend sections three, five, six, and twelve of an act known as the "net container act," approved May 24, 1913.

(Approved June 7, 1915. In effect August 8, 1915.)

The people of the State of California do enact as follows:

SECTION 1. Sections three, five, six, and twelve, of the act of the legislature of the State of California designated "the net container act," designed to protect purchasers of any commodity within its provisions against deception as to the quantity or amount of the commodity purchased, and providing for the indicating of the net quantity of foodstuffs and stuffs intended to

be used or prepared for use as food for human beings when sold or offered for sale, or exposed for sale, in containers, and providing penalties for the violation thereof, approved May 24, 1913, is hereby amended to read as follows:

SEC. 3. The provisions of this act apply to foodstuffs and stuffs intended to be used or prepared for the use as food or medicine for human beings and shall apply to any commodity intended to be used or consumed by human beings.

SEC. 5. The designation of the quantity of the commodity required by section 4 of this act shall be in terms of weight, measure or numerical count, subject to the following provisions:

(*a*) The quantity of the content so marked shall be the amount of food or stuff in the package.

(*b*) If the designation is by weight it shall be in terms of avoirdupois pounds and ounces; if designation is by liquid measure, it shall be in terms of the United States gallon of 231 cubic inches and its customary subdivisions, *i.e.*, in gallons, quarts, pints, or fluid ounces; if designation is by dry measure, it shall be in terms of the United States standard bushels, pecks, quarts, pints or half pints; *provided* that, by like method, such designations may be in terms of the metric system of weight or measure.

(*c*) The quantity of solids shall be designated in terms of weight, and of liquids, in terms of measure, except in case of an article in respect to which there exists a definite trade custom, otherwise the designation may be in terms of weight and measure in accordance with such custom.

(*d*) The quantity of the contents shall be designated in terms of weight or measure, unless the container be marked by numerical count and such numerical count gives accurate information as to the quantity of the food in the package. When designation is by numerical count it shall be in English words or Arabic numerals.

(*e*) The quantity of the contents may be stated in terms of minimum weight, minimum measure or minimum count, but in such cases the designation must approximate the actual quantity and there shall be no tolerance below the stated minimum.

(*f*) The quantity of viscous or semi-solid foods, or of a mixture of solids and liquids, may be stated in terms of weight or measure, but the statement shall be definite and shall indicate whether the quantity is expressed in terms of weight or measure.

SEC. 6. The provisions of this act shall not apply:

(*a*) To any sale of a commodity within the provisions of this act when such sale is made from bulk and the quantity is weighed, measured or counted for the immediate purpose of such sale.

(*b*) To a sale of any container of an ornamental or symbolic character with which a quantity of some commodity is sold as merely incidental.

(*c*) To a sale of a commodity in any container of a net weight of 2 ounces or less, or of a commodity in any container of a measure of 2 fluid ounces or less, or of a commodity in any container of a numerical count of six or less.

(*d*) To the sale of medicine, when prescribed by a licensed physician, or pharmaceutical preparations or mixtures of two or more medicinal substances.

SEC. 12. All acts and parts of acts inconsistent with or in conflict with any of the provisions of this act are hereby repealed.

(*a*) It shall not be held to be a violation of the provisions of this act to sell or offer for sale any commodity contained in a container which complies with the provisions and requirements of any act of congress or the opinions and regulations as issued by the secretary of agriculture and appertaining to net weight or measure.

(*b*) The enactment of the provisions of this act snall be under the supervision of the State superintendent of weights and measures.

COMPARISON OF METRIC SYSTEM WITH THE UNITED STATES METHOD OF WEIGHTS AND MEASURES

Are (100 square meters) equal to 119.6 square yards.
Bushel equal to 2,150.42 cubic inches, 35.24 liters.
Centare (1 square meter) equal to 1,550 square inches.
Centigram (1/100 gram) equal to 0.1543 grain.
Centiliter (1/100 liter) equal to 2.71 fluid drams, 0.338 fluid ounce.
Centimeter (1/100 meter) equal to 0.3937 inch.
1 Cubic centimeter equal to 16.23 minims (Apothecaries').
10 Cubic centimeters equal to 2.71 fluid drams (Apothecaries').
30 Cubic centimeters equal to 1.01 fluid ounces (Apothecaries').
100 Cubic centimeters equal to 3.38 fluid ounces (Apothecaries').
473 Cubic centimeters equal to 16.00 fluid ounces (Apothecaries').
500 Cubic centimeters equal to 16.90 fluid ounces (Apothecaries').
1,000 Cubic centimeters equal to 33.81 fluid ounces (Apothecaries').
Decigram (1/10 gram) equal to 1.5432 grains.
Decimeter (1/10 meter) equal to 3.937 inches.
Deciliter (1/10 liter) equal to 0.845 gill.
Decagram (10 grams) equal to 0.3527 ounce.
Decaliter (10 liters) equal to 9.08 quarts (dry), 2.6418 gallons.
Decameter (10 meters) equal to 393.7 inches.
Dram (Apothecaries' or Troy) equal to 3.9 grams.
Foot equal to 0.3048 meter, or 30.48 centimeters.
Gallon equal to 3.785 liters.
Gill equal to 0.118295 liter, or 142 cubic centimeters.
Grain (Troy) equal to 0.064804 gram.
Grain equal to 0.0648.
Gram equal to 15.432 grains.
Hectare (10,000 square meters) equal to 2.471 acres.
Hectogram equal to 3.5274 ounces.
Hectoliter (100 liters) equal to 2.838 bushels, or 26.418 gallons.
Hectometer (100 meters) equal to 328 feet 1 inch.
Hundredweight (112 pounds Avoirdupois) equal to 50.8 kilograms.
Inch equal to 0.0254 meter.
Inch equal to 2.54 centimeters.
Inch equal to 25.40 millimeters.
Kilogram equal to 2.2046 pounds, or 35.274 ounces.
Kiloliter (1,000 liters) equal to 1.308 cubic yards, or 264.18 gallons.

Kilometer (1,000 meters) equal to 0.62137 mile (3,280 feet 10 inches).
Liter equal to 1.0567 quarts, 0.264 gallon (liquid), or 0.908 quart (dry).
Meter equal to 39.3700 inches, or 3.28083 feet.
Mile equal to 1.609 kilometers.
Mile equal to 5,280 feet, or 1,609.3 meters.
Millier, or tonneau, equal to 2,204.6 pounds.
Milligram equal to 0.0154 grain.
Millimeter (1/1000 meter) equal to 0.0394 inch.
Myriagram equal to 22.046 pounds.
Myriameter (10,000 meters) equal to 6.2137 miles.
Ounce (Avoirdupois) equal to 28.350 grams.
Ounce (fluid) equal to 28.3966 cubic centimeters.
Ounce (Troy or Apothecaries') equal to 31.104 grams.
Peck equal to 9.08 liters.
Pint (liquid) equal to 0.47318 liter.
Pound (Avoirdupois) equal to 453.603 grams.
Pound (English) equal to 0.453 kilogram.
Pound (Troy) equal to 373.25 grams.
Quart (liquid) equal to 0.94636 liter.
Quintal equal to 220.46 pounds.
Scruple (Troy) equal to 1.296008 grams.
Ton equal to 20 hundredweight equal to 2,240 pounds (Avoirdupois) or 1,016.070 kilograms.
Yard equal to 0.9144 meter.

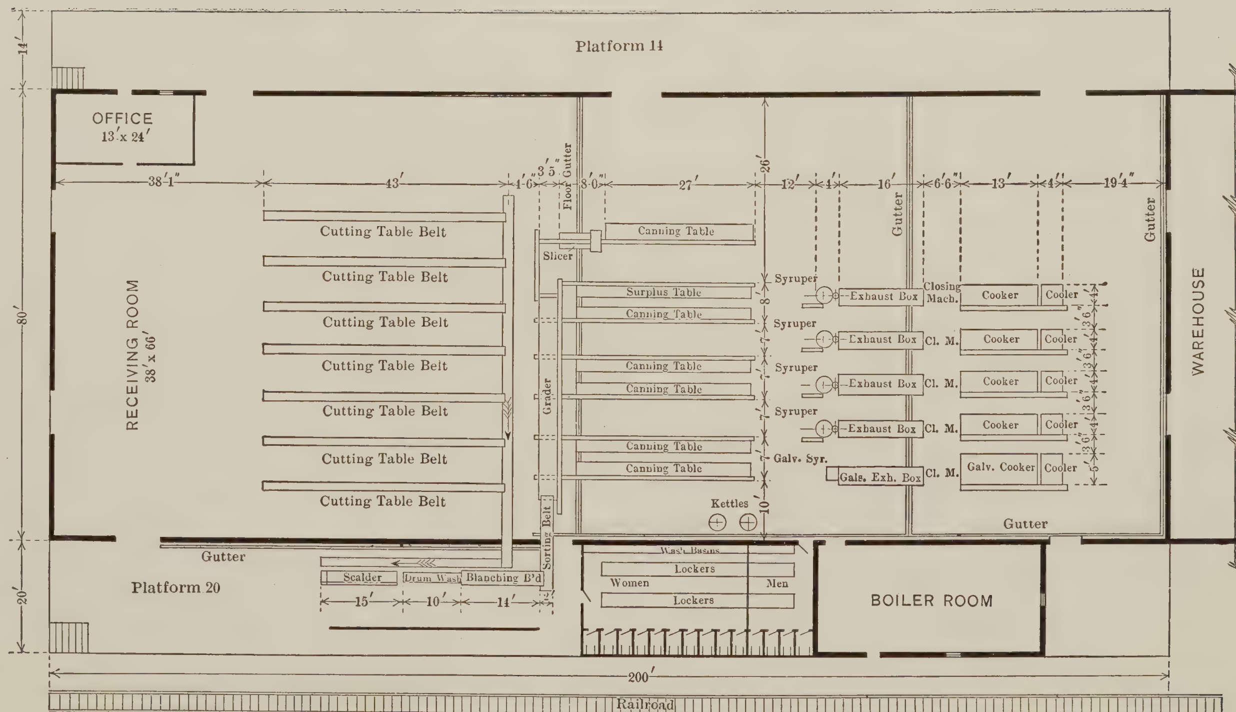
TABLE OF MULTIPLES

Centimeters × 0.3937 equal inches.
Centimeters × 0.0328 equal feet.
Centimeters, cubic, × 0.0338 equal apothecaries' fluid ounces.
Diameter of a circle × 3.1416 equal circumference.
Gallons × 3.785 equal liters.
Gallons × 0.833565 equal imperial gallons.
Gallons, imperial, × 1.199666 equal U. S. gallons.
Gallons × 8.33505 equal pounds of water.
Gallons, imperial, × 10 equal pounds of water.
Gallons, imperial, × 4.54102 equal liters.
Grains × 0.0648 equal grams.
Inches × 0.0254 equal meters.
Inches × 25.4 equal millimeters.
Miles × 1.609 equal kilometers.
Ounces, troy, × 1.097 equal ounces of avoirdupois.
Ounces, avoirdupois, × 0.9115 equal ounces troy.
Pounds, avoirdupois, × 0.4536 equal kilograms.
Pounds, avoirdupois, × 0.8228572 equal pounds troy.
Pounds, troy, × 0.37286 equal kilograms.

Pounds, troy, $\times$ 1.21527 equal pounds avoirdupois.
Radius of a circle equal 6.283185 $\times$ circumference.
Square of the radius $\times$ 3.1416 equal area.
Square of the circumference of a circle $\times$ 0.07958 equal area.

MISCELLANEOUS MEASURES

Barrel of flour equal to 196 pounds.
Barrel of salt equal to 280 pounds.
Bale of cotton (in America) equal to 400 pounds.
Bale of cotton (in Egypt) equal to 90 pounds.
Bag of Sea Island cotton equal to 300 pounds.
Cable equal to 120 fathoms.
Can equal to 35 pounds.
Cask of lime equal to 240 pounds.
Fathom equal to 6 feet.
Hand equal to 4 inches.
Hogshead equal to 63 gallons.
Keg (nails) equal to 100 pounds.
Noggin, or nog, equal to $^5/_{16}$ of a pint.
Pace equal to 3.3 feet.
Palm equal to 3 inches.
Pipe equal to 2 hogshead.
Stone equal to 14 pounds.
Tun equal to 2 pipes.
Cubic foot of water weighs 62.4 pounds.
Cubic foot of water is 7.48 gallons.
Gallon of water weighs 8⅓ pounds.
Gallon of water is 231 cubic inches.
In England, wool is sold by the sack, or boll, of 22 stones, which, at 14 pounds to the stone, is 308 pounds.
A pack of wool is 17 stones and 2 pounds, which is rated as a pack load for a horse. It is 240 pounds.
Sack of flour equal to 280 pounds.
A tod of wool is 2 stones of 14 pounds.
A wey of wool is 6¼ tods. Two weys, a sack.
A clove of wool is half a stone.



Plan of a Modern Canning Plant.

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Wiley Special Subject Catalogues

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